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Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC Research Document 86/88

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Comité scientifique consultatif des
pêches canadiennes dans l'Atlantique

CSCPCA Document de recherche 86/88

Assessment of the 4TVn (Jan - Apr) Cod Stock for 1986

by

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ABSTRACT

The provisional nominal catch of cod in NAFO Division 4T and Sub-division 4Vn (Jan-Apr) in 1985 is 61,112 t, approximately 10% less than the TAC, but 1752 t greater than in 1984. Ageing discrepancies were observed in 1985 but their effect on the assessment could not be quantified. Sampling of landings was as extensive as 1984 with 71,114 fish measured and 7510 otoliths collected. The 1980 year-class comprised 41.7% of the catch while the 1977, 1978 and 1979 year classes comprised a further 39.4%. The standardized catch rate for 1985 is up from 1984 from 0.614 to 0.653 t/h, still lower than in 1983, but comparable to 1980-1982. The standardized catch rate for the Quebec fleet with the preliminary information for 1986 shows an increase over 1985. The population numbers estimated from the E.E. Prince groundfish survey indicate stable numbers since 1982 with the 1980 year-class being the largest observed in the time series. Full recruitment to the fishery is attained at age 8. Analyses using the "SURVIVOR" programme indicated an increased catchability of cod to the research survey. The results of a "SURVIVOR" analysis for the period 1979-1985 indicate Ft in 1985 of 0.6 to 0.7. From the SPA calibrated with standardized catch rates and research vessel population numbers, an Ft of 0.65 for 1985 was considered appropriate. If the 1986 TAC of 60,000 t is caught, then the 1987 catch at Fo. 1 would be 24,059 t.

RÉSUMÉ

Les prises nominales provisoires de morue dans la Division 4T et la Sous-Division 4Vn (Jan.- Avr.) de l'OPANO sont de 61,112 t en 1985. Ces prises sont inférieures de 10% au TPA mais de 1752 t de plus qu'en 1984. Des divergences dans la détermination de l'âge en 1985 ont été observées mais leurs effets sur cette évaluation n'ont pu être calculés. L'échantillonage des débarquements a été aussi important qu'en 1984; 71 114 poissons ont été mesurés et 7 510 otolithes ont été prélevées. La classe d'âge de 1980 constituait 41.7% des prises tandis que les classes d'âge de 1977, 1978 et 1979 constituaient 39.4%. Le taux de capture standardisé pour 1985 est supérieur à celui de 1984 (0.653 t/h et 0.614 t/h respectivement). Ce taux est inférieur à celui de 1983 mais cependant comparable aux taux observés de 1980 à 1982. Le taux de capture standardisé pour la flotte du Québec avec l'information préliminaire de 1986 indique une augmentation en 1986. Les effectifs estimés par la croisière d'automne de poissons de fonds du E.E. Prince sont demeurés stable depuis 1982. La classe d'âge de 1980 est la plus importante dans la période observée. Les individus sont pleinement recrutés à l'âge de 8 ans. Les résultats de l'analyse "SURVIVOR" indiquent une augmentation de la capturabilité de la morue dans les croisières de recherche. Les résultats de "SURVIVOR" pour la période 1979-1985 donnent lieu a un Ft pour 1985 de 0.6 à 0.7. D'après les calibrations de l'ASP avec les taux de capture standardisés et les effectifs estimés par la croisière de recherche, un Ft de 0.65 pour 1985 a été jugé approprié. Si le TPA de 60 000 t pour 1986 est capturé alors la prise à F0.1 = 0.2 pour 1987 sera de 24 059 t.

1. INTRODUCTION

Because of the migratory nature of the stock, the cod fishery in NAFO Division 4T and Sub-division 4Vn (Jan-Apr) is the object of two distinct fisheries. In the winter, the fishery is conducted in the Sydney Bight area (NAFO Sub-division 4Vn) and the fleet is composed almost entirely of otter trawlers from France, Nova Scotia and Newfoundland. In early spring, the stock migrates into NAFO Division 4T where it remains until late fall. When in 4T, the cod stock is subject to the "summer" fishery. This fishery is more diverse by the variety of fleets exploiting the stock and the spatial and temporal variations in landings. Fleets of small draggers, longliners, handliners and gillnetters (tonnage class (TC) 0 and 1) exploit the stock in the inshore areas of the Gaspe Peninsula, Baie des Chaleurs and northeastern N.B. coasts, P.E.I. Gulf coast, western Cape Breton and Magdalen Islands.

Larger vessels commonly referred to as the "midshore" fleet (otter trawlers and seiners, TC 2-3) fish the resource in offshore areas of the Gaspe Peninsula and northeastern New Brunswick shore (NAFO Sub-divisions 4Tn, 4Tk,4Tl), Magdalen Islands and Chéticamp, Nova Scotia area (NAFO 4Tf,4Tg). The midshore fleet located in Lamèque, Shippegan and Caraquet is highly mobile and follows the cod in its migration from the Gaspe Peninsula to Cape Breton. Some of the major landing ports of the midshore fleet are Grande-Rivière, Newport, Rivière-aux-Renards (Québec), Lamèque, Shippegan and Caraquet (N.B.), and Chéticamp (N.S.). Finally, the two offshore fleets composed of tonnage class 4 otter trawlers are based in the Lamèque, Shippegan, Caraquet area (N.B.) and Souris, P.E.I. In addition, non-Gulf based vessels also exploit this stock in 4T. These are mostly TC-2 and 3 trawlers and seiners from Nova Scotia. Their catch usually amounts to less than 5% of the total catch on this stock.

Over the last 36 years, nominal catches have varied from a high of over 104,000 t. in 1956 ,shortly after the introduction of the otter trawler in the fishery, to a low of 22,000 t. in 1977 (Table 1). Since 1977, nominal catches have increased and have fluctuated around an average of 60,000 t. since 1981.

Preliminary information for 1986 indicate that the catch to date (as of September 10) for 1986 is approximately 53,000 t, an increase of nearly 5,000 t over 1985 at a similar date.

A) Nominal catches and description of the fishery

Nominal catch for 1985 was calculated using the provisional data supplied by the Statistics Branches of the Scotia-Fundy, Newfoundland, Quebec and Gulf regions of the Department of Fisheries and Oceans (DFO). Catches for the French fleet fishing in 4Vn were obtained from quota monitoring personnel of the Department. The nominal catch for 1985 is 61,112 t., or approximately ten percent less than the established TAC. Breakdowns of nominal catches by month, gear and country are presented in Table 2 and 3. The winter fishery in 4Vn represented approximately one quarter of the total catches in 4TVn (Jan-Apr), divided equally between France and Canada (Maritimes and Newfoundland).

In the 1985 summer fishery, the proportions caught by each country changed over the two previous years. Maritimes and Newfoundland combined caught 38% of the total 4TVn catches and Quebec caught the same proportion. In 1983 and 1984, Maritimes and Newfoundland had caught 50% of the total catches with Quebec taking the remaining quarter. The catch reported for miscellaneous and unknown gear has declined to a negligible amount due to better reporting of catches by Quebec and Gulf regions.

In 1985, mobile gears (otter trawls and seines) caught over 80% of the total catches, an increase of about 10% over the four previous years (Figure 1). This is mainly due to Quebec otter trawlers which doubled their catches of 1984 and 1983. The reduction in the fixed gear catches is primarily due to gillnet landings in the Maritimes, which dropped from 6138 t. in 1984 to 1810 t. in 1985. The catch by month (Figure 2) followed the general trends of previous years with larger catches in January and May. Catches in May were lower than in 1983 and 1984 but declined less over the summer months than in previous years.

In 1986, preliminary information indicates that the total catch to date in this fishery is higher than in the previous years. Despite this increase, landings for the fixed gears are down (as of Sept. 10) approximately 1,000 t from 1985 at similar date (Figure 3). Data on the 4Vn French fishery in 1986 obtained from observer reports indicate a catch of 6475 t.

Revised catches for 1984 are presented in Appendices I and II. The final landings for 1983 are 856 tons lower than reported in Chouinard and Clay (1985), and are due to a reduction in the reported catch for France.

B) Information relevant to the assessment

i) Age determination

Ageing of otoliths for the 4TVn cod stock has been done by the Gulf Region since 1982. In 1983, the ager was calibrated by St. Andrews agers. In early 1986, a sample of 94 otoliths collected during the 1985 research survey was sent to St. Andrews for comparison purposes. The overall agreement between the two agers was low (55%). There was a clear trend for the St. Andrews readings to be one year older (Appendix III). The difference occurredin most cases in the interpretation of the last annulus, where one additional pair of wide opaque and narrow hyaline zones was observed by St. Andrews.

Another sample comprised of a random sample of otolith from the 1985 commercial fishery was submitted subsequently. Results were similar to the first comparison in terms of agreement and trend (Appendix IV).

The ageing of the samples was analyzed using a paired-t test as well as a chi-square test, and the results for both samples were similar. The paired-t tests indicated that the means of the samples aged in St. Andrews were significantly different from the means of the samples aged by the Gulf Region. The chi-square tests indicated that the frequency distributions of each sample were not statistically different (X^2 = 5.14, DF = 12, α = 0.05; X^2 = 16.45, DF = 23, α = 0.05).

As there was insufficient time to re-age the otoliths used in the estimation of catch at age and research vessel population numbers at age, the current ages were used in the assessment. The impact of ageing discrepancies on the assessment could not be quantified but should be considered when examining the results of the assessment.

ii) Software Used

The programs used for the various tasks in this assessment are listed in Table 4.

2. INPUT DATA

A) Commercial Fishery Data

i) Catch and weight at age

Sampling of the 4TVn cod fishery in 1985 was as extensive as in 1984: 71,114 fish were measured for length and 7,510 otoliths were collected. Details of the sampling by month and gear is shown in Table 5. The 4Vn fishery (otter trawl, Jan.-Mar.) was well sampled with port samples for the Canadian fishery and observer samples on the French fishery. There were some deficiencies, particularly in the sampling of otter trawls (Oct.-Dec.) and seines (July-Sept., Oct.-Dec.) for otoliths. Fifteen age-length keys (Table 6) were produced and used to calculate the 1985 catch at age (Table 7). The 1980 year-class is dominant in the catch at age. This year-class had been noted as very strong in previous assessments (Lever and Waite, 1984; Chouinard and Clay, 1985) from research vessel data.

The corresponding weights at age (Table 8) were calculated using the following length-weight relationship obtained from the 1985 E.E. Prince fall groundfish survey (random stations only):

$$Wt_g = 0.00454766\ L_{cm}^{3.177251}$$

Selective gears such as gillnets and longlines (Keys 9 through 13) have a tendency to select heavier fish at age than the otter trawl and seines. Weights at age in the third and fourth quarters are often less than the ones in the first and second quarters (i.e. Age 7, Keys 1,2,3,4; Table 8). Examination of lengths at age in otter trawls in the period 1981-85 revealed similar patterns (Table 9). Although no definite reason can be given for this, factors such as the acceptability of scrod by plants, ageing discrepancies or even stock mixing are possible. Using the following formula, the 1985 weights were calculated and the weights at age for the period 1971-1984 were recalculated (Table 10).

$$\frac{\sum_i c_{i,j} \quad w_{i,j}}{\sum_i c_{i,j}}$$

where c = catch numbers
w = weight
i = key index
j = age index

Except for ages 11 and over in 1983 and 1984 the average weights at age did not change significantly over the ones calculated in the two previous assessments (Lever and Waite, 1984, Chouinard and Clay, 1985). These weights were considered as approximately mid-year weights as in the two previous assessments of this stock (Lever and Waite, 1984; Chouinard and Clay, 1985). Weights at age are lower in 1985 than in 1984 in all age classes from 3 to 11. The catch and weight at age for 1983 and 1984 were recalculated to reflect changes in the nominal catch using the same age-length keys used in the previous assessment (Chouinard and Clay, 1985).

The matrix of catch at age 1971 to 1985 is presented in Table 11. As mentioned earlier, the 1980 year-class is dominant. As in the previous years, few fish are found older than 11 years old.

Length frequencies collected in the first half of 1986 were compared with the corresponding frequencies for the period 1981-1985 (Figure 4, 5, 6). For trawlers in the first quarter (4Vn), trawlers in the second quarter and seines in the second quarter, a reduction in the modal length is observed. Prior to 1986 the three most important length classes were mostly the 46 to 52 groupings. This is consistent with the large 1980 year-class becoming more recruited.

From the large percentage of smaller fish in 1986, it appears that some above average year-classes may be following the 1980 year-class although this could also be the result of changing discard rates.

ii) Catch per unit of effort

Commercial catch rates for Maritimes-Quebec and Newfoundland for otter trawlers, Danish and Scottish seiners and longliners were standardized for the years 1966 to 1985 for the 4TVn fishery using a multiplicative model (Gavaris, 1980). The standard used was Maritimes-Quebec side trawlers (TC-2) fishing in January in 4T. The effort type chosen were hours for trawlers and seiners and thousands of hooks for longliners. Observations with catch less than 10 t. or effort less than 10 units were excluded from the analysis. Results of the analysis are presented in Table 12 and 13. The predicted catch rates indicate a peak in 1983 with marked decrease in 1984 and slight increase in 1985 (Table 14, Figure 7). NAFO and Observer data for the French fishery in 4Vn (catch/day) indicate a decrease in catch rates since the high level attained in 1984 (Figure 8).

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For 1986, indications are that catch rates were higher than in 1985 in the spring. A multiplicative model was used for the Quebec information up to September 9. This analysis indicated that catch rates were higher in 1986 over 1985 (Table 15, Figure 9).

iii) Discard rates

Preliminary analysis of four trips (49 sets) sampled by Quebec observers in NAFO 4Tn in June, July, September and October 1985 indicated a discard rate of 7.89% by weight. This compares to the value of 6.03% found by Chouinard and Metuzals (1985) in a study conducted in the fall of 1984.

Saint-Pierre and Miquelon vessels had a discard rate of 3.86%. These discards are deducted from their quota. In order to minimize these, French vessels are using mesh sizes from 5.5 in. to 5.75 in. Generally, metropolitan France vessels do not reject fish at sea, as they have fish meal plants on board.

B) Research Survey Data

Population numbers estimated from the E.E. Prince fall groundfish survey indicated an increase of the numbers in the population to levels observed in 1982 and 1983 (Table 16). The research vessel data have been re-analyzed using a new program (RVAN) and results are not significantly different from previous analyses except for 1975 and 1978. The data for these two years had been adjusted to account for large sets. The series presented here is not adjusted to make the series consistent. The 1980 year-class which was observed as being strong in previous years is the largest ever observed of 5 year olds. Two indices of catch per unit of effort in the research vessel survey were calculated. These are weight per standard tow and numbers per standard tow. Both are weighted by strata surface. A least squares regression analysis of the weight per tow in surveys versus standardized commercial catch rates indicated a significant relationship ($r = 0.87$), (Figure 10).

Year	Weight/tow	Number/tow
71	39.4	32.1
72	38.2	34.1
73	39.5	34.4
74	35.7	30.1
75	27.1	26.4
76	34.8	59.5
77	43.7	50.0
78	77.0	77.3
79	107.4	136.2
80	113.8	133.8
81	202.7	226.3
82	146.2	159.8
83	117.4	166.1
84	90.5	121.9
85	173.8	232.6

3. ESTIMATION OF PARAMETERS

A) Survivor analyses

Estimates of the population numbers were derived using the "SURVIVOR" program (Rivard, 1982). Runs were made using the entire series (1971-1985), however, it was discovered that by changing the calibration block, the value of K (constant of proportionality) was changing, which made the analysis unreliable. This had been noted in the previous assessment of this stock. Examination of age by age plots of "SURVIVOR" population number estimates versus the research vessel population estimates showed a break in the series in 1978-1979 which is interpreted as a change of availability to the survey gear (catchability). The data points prior to 1979 appear to be part of a different relationship than the ones after (see Figure 11 as an example).

"SURVIVOR" analyses were therefore conducted on the data for the 1979-1985 period. Various calibration blocks indicated K values of between 0.86 to 0.90 with few outliers in the residuals. Results of the analysis using 1984 and age 8 as the last year and age in the calibration block are shown in Table 17. Four outliers in the residuals were observed. Age by age plots of "SURVIVOR" population numbers versus research vessel population estimates are shown in Figure 12. The "SURVIVOR" analyses indicated terminal fishing mortalities of 0.60 to 0.70 in 1985 on the fully recruited year classes. Results indicate that the 1980 year-class is approximately 1.5 times the size of the 1977 year-class.

Doubleday (1981) conducted a similar analysis using the 1971 to 1979 data and concluded that although positive residuals in 1979 were not statistically significant, an availability change in 1979 could not be ruled out. It appears now that this change in availability has been confirmed.

There is no apparent survey-related cause for this change in catchability. Over the period 1971-1985, the same vessel (E.E. Prince) was used to do the survey which has always been in September. The random stratified survey scheme did not change over the series. The same equipment was used on the vessel and average towing speed was fairly constant over the time period of the change in availability.

Recent feeding studies on cod (Waiwood and Losier, 1982; Waiwood and Majkowski, 1984) have indicated a marked reduction in occurrence of herring in the stomachs over previous studies conducted in the period 1959-1973. At the same time, the highest dietary levels of snow crab (Chionoecetes opilio) since the early 1960's were observed in 1980-1981. These dietary changes would imply that cod remain closer to the bottom and therefore increase their availability to bottom trawls used in research surveys and the commercial fishery.

B) Partial recruitment

Partial recruitment (PR) for 1985 was estimated by two methods. The historical averaging method as described by O'Boyle (1981) was first used.

Since mesh size regulation increased from 120 mm to 130 mm in 1981, it was felt that prior years could not be used in the calculation. This method gave full recruitment at age 10 and gave a low value at age 5 (Table 18). Because age 5 was dominant in the catch at age for 1985, it was felt that the value at that age was too low. In addition, catch by gear (Figure 1) indicated an increase in the proportion caught by otter trawlers. Because of the selectivity of these gears, higher values would be expected, therefore this vector was rejected.

The ratio normalized on fully recruited ages smoothed (RNFS) method to compare commercial and research catches (Rivard, 1984) was used to calculate a PR vector for 1983 to 1985. The normalization block used was ages 9 to 12. The resulting vector is shown in Table 18. Full recruitment occurs at age 8 and the vector is flat top.

C) Sequential Population Analysis

The natural mortality was assumed at 0.200 and the following F on oldest age were calculated by iteration. They are:

71	72	73	74	75	76	77	78
.569	.284	.303	.488	.688	.357	.274	.332

79	80	81	82	83	84
.424	.269	1.050	.630	.353	.627

The virtual population analysis (VPA) was run with F_t for 1985 between 0.30 to 0.80. The resulting population numbers for the 1977 and 1980 year-classes indicated that the PR on age 5 was too low. The PR on age 5 was adjusted to 0.364 to obtain the 1.5 ratio between the two year-classes obtained from the "SURVIVOR" analyses. The input of an F_t of 0.3 resulted in fishing mortalities greater than 0.5 in fully recruited age classes from 1979 to 1984. This is not consistent with trends observed in fishing effort which has been relatively stable in recent years and indicated a higher F_t for 1985.

Calibrations (Table 19) of 4+ and 5+ mean population biomass versus catch rate indicated an F_t of 0.75 and 0.65 respectively using the minimum sum of the last three standardized residuals squared as calibration criterion. Calibrations using 6+ mean population biomass versus catch rates indicated a terminal fishing mortality of 0.45, however, these age classes represented less than 50% of the numbers caught in 1985.

Using the same criterion, the calibrations of age 4+ and 5+ mean population numbers versus the same ages in the research vessel surveys for 1979-1985 indicated F_t in the range of 0.6 to 0.7. The calibration of 6+ mean population numbers versus the same ages in the research vessel surveys for 1979-1985 indicated an F_t of 0.50 but again due to the lower percentage of removals represented by this relationship, it was given a smaller weight in the estimation of F_t for 1985.

Based on these relationships and the results of the "SURVIVOR" analyses, an F_t of 0.65 for 1985 is the best estimate. The resulting population numbers, biomass and fishing mortalities are presented in Table 20, 21 and 22, respectively.

This analysis represents a major shift in the view of this resource. The current estimates of fishing mortalities since 1982 are approximately double what had been estimated in recent assessments of this stock. The main reason for this change is the results of the "SURVIVOR" analysis. It indicated that the research vessel survey abundance estimate can no longer be treated as an homogeneous series as had been done previously because of the apparent change in availability. The type of ageing discrepancies noted may cause an apparent change in availability (i.e. overestimation of older ages would tend to raise availability factor) however probably not of the magnitude observed here.

D) General Production Models

The Schaefer general production model was conducted using the nominal catch and the effort data derived from the multiplicative model. Fishing effort was averaged over 3 years. Results indicate a maximum sustainable yield of 56,466 tons, slightly lower than the catch in recent years (Table 23, Figure 13). The yield at 2/3 EMSY is 50,193 t.

A non-equilibrium surplus production model (Rivard and Bledsoe, 1978) was attempted with the effort values from the multiplicative model. The results of this analysis were suspect because of the apparent change in catchability over the period observed.

4. ASSESSMENT RESULTS

Examination of the fishing mortalities table (Table 22) indicates that this stock has been subjected to high fishing mortalities (above 0.5) at least since 1979. Despite these high fishing mortalities, the mean population biomass (age 3+) (Table 21) has increased to attain a high level in 1980 and has remained relatively stable because of above average recruitment from the 1973, 74, 75, 77 and 1980 year-classes.

At the current high fishing mortality levels, failure in recruitment could result in a collapse of this fishery. Fishing mortalities closer to the reference level are therefore desirable and would probably result in even higher and more stable catch rates in the longer term than those observed in recent years. Growth overfishing would be reduced and the age composition of the catch would become more balanced.

5. PROGNOSIS

The input parameters used are shown in Table 24. The geometric mean of age 3 numbers from the VPA for the period 1971 - 1984 (77 million) was used to estimate the recruitment in 1985 and subsequent years. The weights at age are the average of the years 1983 to 1985. Natural mortality was assumed at 0.20. The partial recruitment is the one used in the VPA.

Assuming that the 1986 TAC of 60,000 t is caught, then the 1987 catch at $F_{0.1}$ (0.20) would be 24,059 t. Fishing at $F_{0.1}$ in 1986 and 1987 would result in catches of 23,489 t and 29,530 t respectively. Results are presented in Table 25.

6. ACKNOWLEDGMENTS

The authors wish to thank Lorette Chiasson who assisted in the preparation of figures and tables in the document; Mr. J. J. Hunt and R. Robicheau who did the comparison for the age determinations. Doug Clay provided the research vessel abundance indices of catch rate and updated population numbers and Darlene Jones helped in the preparation of tables. Brenda White and Dianne Aubé typed the document.

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Table 1: Nominal 4TVn (Jan-Apr) cod catch and TAC for 1950 to 1985. Sources: a. 1950-1964 from Lett 1978, b. 1965-1983 from NAFO statistics; c. 1984 and 1985 provisional from Department of Fisheries and Oceans, Statistics Branches, d. preliminary as of Sept. 10, 1986).

YEAR	NOMINAL CATCH	TAC	YEAR	NOMINAL CATCH	TAC
1950	44023[a]	-	1968	46551	-
51	34827	-	69	47819	-
52	41956	-	1970	64465	-
53	58911	-	71	56375	-
54	63901	-	72	65291	-
1955	65227	-	73	50635	-
56	104469	-	74	48747	63000
57	89131	-	1975	42471	50000
58	86582	-	76	33415	30000
59	70720	-	77	22219	15000
1960	66013	-	78	37892	38000
61	65583	-	79	55996	46000
62	66664	-	1980	54634	54000
63	70202	-	81	65177	53000
64	60547	-	82	58193	60000
1965	63027[b]	-	83	61295	62000
66	54851	-	84	59360[c]	67000
67	41316	-	85	61112[c]	67000
			86	53000[d]	60000

Table 2: Provisional 4T cod catches (t round weight) during 1985 by gear type and month in Maritime Provinces, Newfoundland and Quebec.

GEAR	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL	% OF 4TVn (Jan-Apr) CATCH
MARITIMES														
Otter trawl (side)	48	1		11	606	316	261	12	514	549	929	372	3619	5.92
Otter trawl (stern)	144			477	698	191	265	311	580	239	179	861	3945	6.46
Shrimp trawl					28	59	26		32	28			173	0.28
Danish seine			3	485	3115	1911	1062	720	662	775	2052	1015	11800	19.31
Scottish seine					12								12	0.02
Gillnets	1			9	203	145	572	409	310	99	62		1810	2.96
Longline		2			2	38	88	74	70	57	440	89	860	1.41
Handline					4	54	118	193	186	110	31	1	697	1.14
Traps	1				23	13	33	24	22	5			121	0.20
Miscellaneous					7	1	9	11	6	7	23	15	79	0.13
TOTAL	194	3	3	982	4698	2728	2434	1754	2382	1869	3716	2353	23116	37.83
NEWFOUNDLAND														
Otter trawl (stern)						2	57	54					113	0.18
Shrimp trawl							1						1	0.00
Gillnets					18	1	2	4					25	0.04
Longline						2	4	2					8	0.01
Miscellaneous					4	10	1						15	0.02
TOTAL	0	0	0	0	22	15	65	60	0	0	0	0	162	0.27
QUEBEC														
Otter trawl (side)				203	1772	2423	3275	1525	1833	1498	426		12955	21.20
Otter trawl (stern)				203	313	374	451	377	461	300	88		2567	4.20
Bottom pair trawl							25	109	67	41	27		269	0.44
Shrimp trawl				1	21	9		99	228	127	38		523	0.86
Danish seine						16	7	2	2				27	0.04
Gillnet				99	1055	759	591	595	173	51	4	1	3328	5.45
Longline				23	138	378	402	558	499	290	7		2295	3.76
Handline				3	49	203	339	283	284	128	14	1	1304	2.13
Miscellaneous						13	1		7	2			23	0.04
TOTAL	0	0	0	532	3348	4175	5091	3548	3554	2437	604	2	23291	38.11
TOTAL 4T	194	3	3	1514	8068	6918	7590	5362	5936	4306	4320	2355	46569	76.20

Table 3: Provisional 4Vn (Jan.-Apr.) cod catches (t round weight) during 1985 by gear type and month in Maritime Provinces, Newfoundland and France.

GEAR TYPE	J	F	M	A	TOTAL	% OF 4TVn (Jan-Apr) CATCH
MARITIMES						
Otter trawl (side)	951	837	543	229	2560	4.19
Otter trawl (stern)	1312	889	168	159	2528	4.14
Longline	-	-	-	1	1	0.00
Handline	-	-	-	1	1	0.00
TOTAL	2263	1726	711	390	5090	8.33
NEWFOUNDLAND						
Otter trawl (stern)	1091	932	365	10	2398	3.92
TOTAL	1091	932	365	10	2398	3.92
FRANCE						
Otter trawl (stern)	4722	1704	629	-	7055	11.54
TOTAL OF 4Vn	8076	4362	1705	400	14543	23.80

Table 4: Software used in the 1986 assessment of the 4TVn (Jan - Apr) cod stock.

TASK	SOFTWARE	VERSION	LANGUAGE
Catch and weight at age	ALSYSX	2.1	Fortran IV
Commercial catch rates analysis (Multiplicative model)	STANDARD.WS	1.0	APL (STSC)
Research vessel surveys analysis	RVAN	2.3	Turbo PASCAL
Estimation of Survivors	SURVIVOR (in FISH.WS)	1.0	APL (WATCOM)
Fishing mortality on oldest age	AUTOF (in FISH.WS)	1.0	"
Virtual population analysis	VPA (in FISH.WS)	1.0	"
General production model	SCHAEFER (in FISH.WS)	1.0	"
Non-equilibrium production model	(in SURPROD workspace)	-	APL (IP Sharp)
Catch projections	MPROJECT (in FISH.WS)	1.0	APL (WATCOM)

Table 5. 4TVn cod commercial sampling in 1985 (Number measured/Number aged).

GEAR	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
Otter trawl	6786	3058	301	659	2976	1945	3066	2112	3597	2664	977	0	28141
	590	266	0	123	436	184	394	81	240	224	99	0	2637
Otter trawl	4829	5248	0	1409	0	0	0	0	0	0	0	0	11486
(observer)	221	157	0	61	0	0	0	0	0	0	0	0	439
Seines	0	0	0	0	2548	1256	1201	646	1844	1287	1205	0	9987
	0	0	0	0	333	128	141	42	102	124	135	0	1005
Gillnet	0	0	0	575	2538	784	1451	1595	904	193	0	0	8040
	0	0	0	81	308	53	285	162	153	23	0	0	1065
Longline	0	0	0	0	471	1570	1433	2627	2543	963	537	0	10144
	0	0	0	0	96	744	359	296	166	207	70	0	1938
Handline	0	0	0	0	453	495	877	1174	89	228	0	0	3316
	0	0	0	0	43	54	129	177	0	23	0	0	426
TOTAL	11615	8306	301	2643	8986	6050	8028	8154	8977	5335	2719	0	71114
	811	423	0	265	1216	1163	1308	758	661	601	304	0	7510

Table 6: Age-length keys used in the calculation of the 1985 catch at age.

AGE-KEY NUMBER	FISHERY	SAMPLES	SAMPLE SIZE	CATCH (t)
1	OTB JAN.-MAR. FRANCE	L.F.: JAN.-MAR. OTB A.L.K.: JAN.-MAR. OTB	LENGTHS 9816 AGES 378	7055
2	OTB JAN.-MAR. CANADA	L.F. : JAN.-MAR. OTB A.L.K. : JAN.-MAR. OTB	LENGTHS 10145 AGES 856	7281
3	OTB APR.-JUNE	L.F.: APR.-JUNE OTB A.L.K.: APR.-JUNE OTB	LENGTHS 5580 AGES 543	7987
4	OTB JULY-SEPT .	L.F.: JULY-SEPT. OTB A.L.K.: JULY-SEPT. OTB	LENGTHS 8775 AGES 715	10177
5	OTB OCT.DEC.	L.F.: OCT.-DEC. OTB A.L.K.: OCT.-DEC. OTB OCT.-DEC. SNU	LENGTHS 3641 AGES 582	5509
6	SNU APR.-JUNE	L.F.: APR.-JUNE SNU A.L.K.: APR.-JUNE SNU	LENGTHS 3804 AGES 461	5539
7	SNU JULY-SEPT .	L.F.: JULY-SEPT. SNU A.L.K.: JULY-SEPT. SNU JULY-SEPT. OTB	LENGTHS 3691 AGES 1000	2455
8	SNU OCT.-DEC.	L.F.: OCT.-DEC. SNU A.K.L.: OCT.-DEC. SNU OCT.-DEC. OTB	LENGTHS 2492 AGES 582	3842
9	GN APR.-JUNE	L.F.: APR.-JUNE GN A.L.K.: APR.-JUNE GN	LENGTHS 3897 AGES 442	2289
10	GN JULY-DEC.	L.F.: JULY-DEC. GN A.L.K.: JULY-DEC. GN	LENGTHS 4143 AGES 623	2873
11	LL APR.-JUNE	L.F.: APR.-JUNE LL A.L.K. : APR.-JUNE LL	LENGTHS 2041 AGES 840	582
12	LL JULY-SEPT.	L.F.: JULY-SEPT. LL A.L.K.: JULY-SEPT. LL	LENGTHS 6603 AGES 821	1697
13	LL OCT.-DEC.	L.F.: OCT.-DEC. LL A.L.K.: SEPT.-DEC. LL	LENGTHS 1500 AGES 443	883
14	LHP APR.-JUNE	L.F.: APR.-JUNE L.H.P. A.L.K.: APR.-JUNE LHP APR.-JUNE OTB	LENGTHS 948 AGES 840	314
15	LHP JULY-DEC.	L.F.: JULY-DEC. LHP A.L.K.: JULY-DEC. LHP	LENGTHS 2368 AGES 329	1688
	UNKNOWN, TRAPS, DREDGE & NON-SPECIFIED GEARS			941

Table 7: Catch at age (thousands) for the 1985 age length keys.

	AGE KEY NUMBER																	
AGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	SUB TOTAL	UNSAMPLED CATCH	TOTAL
2	–	–	–	–	2	–	–	5	–	–	–	–	–	–	–	7	0	7
3	66	46	15	231	167	38	33	145	1	3	–	10	–	2	49	806	13	819
4	141	295	367	1350	936	283	247	673	4	57	2	91	15	35	145	4641	73	4714
5	2930	2339	1920	4644	2585	1606	890	1624	78	206	13	413	120	146	493	20007	313	20320
6	1412	1009	837	1696	828	1135	368	547	70	291	18	184	72	50	301	8818	138	8956
7	583	637	1014	551	370	682	164	258	305	225	22	117	59	36	115	5138	80	5218
8	524	778	1129	614	250	397	161	199	336	165	45	151	76	39	88	4952	77	5029
9	274	268	330	203	78	120	54	70	110	98	28	70	62	10	26	1801	28	1829
10	200	177	339	156	27	59	49	28	124	91	36	43	44	11	26	1410	22	1432
11	111	17	47	24	11	2	6	13	14	21	12	18	14	2	7	319	5	324
12	–	6	2	5	–	–	3	–	3	3	2	3	2	–	3	32	1	33
13	7	6	4	–	–	–	–	–	–	1	–	–	–	–	–	18	0	18
14	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–	2	0	2
15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0	0	0
16	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1	0	1
TOTAL	6248	5579	6005	9474	5254	4322	1975	3562	1046	1161	178	1100	464	331	1253	47952	750	48702

Table 8: Average weight at age (Kg) for the 1985 age length keys.

AGE KEY NUMBER

AGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2	-	-	-	0.33	0.34	-	-	-	-	-	-	-	-	-	-
3	0.38	0.48	0.62	0.85	0.75	0.81	0.82	0.67	0.97	1.54	-	0.72	0.70	0.53	0.50
4	0.41	0.82	0.80	0.87	0.80	0.97	0.91	0.76	1.00	0.94	0.87	0.96	1.24	0.71	0.74
5	0.82	0.98	0.94	0.93	0.95	1.08	0.99	0.96	1.70	1.71	1.46	1.12	1.18	0.80	0.98
6	1.13	1.29	1.27	1.12	1.24	1.26	1.30	1.33	1.88	2.36	2.08	1.55	1.61	1.00	1.56
7	1.63	1.70	1.48	1.44	1.38	1.52	1.81	1.49	2.10	2.76	2.80	1.80	1.97	1.19	2.11
8	1.68	1.67	1.63	1.66	1.63	1.66	1.78	1.74	2.10	2.96	2.75	2.02	2.11	1.25	2.27
9	1.87	1.91	1.91	1.82	1.81	1.79	1.99	1.74	2.49	3.01	3.39	2.31	2.08	1.31	2.91
10	2.17	2.15	1.94	1.97	2.20	2.20	2.46	2.21	2.77	2.91	3.97	2.44	2.61	1.23	2.29
11	1.63	4.99	2.61	1.97	2.28	7.28	2.04	2.43	3.16	3.01	5.19	2.50	4.06	1.31	2.42
12	-	4.48	2.88	9.41	-	13.30	6.09	-	3.43	9.44	6.93	6.93	10.93	2.88	4.82
13	2.49	5.00	10.68	-	-	14.53	-	-	-	5.48	19.91	12.38	9.90	-	-
14	-	-	9.34	-	-	-	-	-	3.78	-	17.41	10.80	-	-	-
15	-	-	-	-	-	23.68	-	-	-	13.53	12.09	-	-	-	-
16	-	10.29	11.30	-	-	-	-	-	-	-	15.48	-	10.61	-	-
Average	1.13	1.31	1.33	1.07	1.05	1.28	1.24	1.08	2.19	2.47	3.24	1.54	1.90	0.95	1.35

Table 9: Cod average length at age in Otter trawls samples 1981 - 1985.

Quarter	Age 3	4	5	6	7	8	9	10
				1981				
1	--	39.3	43.4	48.1	51.5	54.4	67.4	71.3
2	34.8	41.4	45.7	51.2	55.0	59.2	64.6*	71.0
3	39.2	42.2	46.2	50.7*	53.5*	57.2*	65.0	68.3*
4	40.0	43.1	46.6	52.2	55.3	57.8	62.4*	70.5
				1982				
1	34.0	39.3	45.1	48.8	52.8	55.7	62.2	66.9
2	--	40.0	46.3	49.4	52.6*	54.9*	60.0*	66.0*
3-4	51.37	46.6	47.7	51.0	54.2	54.2*	59.7*	67.6
				1983				
1	41.9	45.3	50.5	51.9	54.8	56.2	58.0	59.6
2	--	42.7*	49.6*	51.0*	52.3*	54.7*	58.8	57.8
3	42.6	47.4	51.2	54.6	57.0	58.8	63.8	74.0
4	46.9	47.8	53.1	54.7	56.3*	59.3	62.5*	70.0*
				1984				
1	45.8	44.6	47.1	52.9	52.6	53.8	58.1	67.0
2	37.0*	46.8	49.9	54.0	54.3	56.0	58.9	62.1*
3	46.4	46.9	49.2*	52.8*	53.8*	56.7	57.6*	61.8*
4	40.7*	44.8*	47.0*	52.6*	54.3	56.3*	58.8	60.8*
				1985				
1	37.7	44.1	46.8	51.1	55.3	54.8	56.9	58.0
2	41.1	44.4	46.8	51.1	53.7*	55.2	57.9	58.1
3	45.2	45.5	46.5*	49.2*	53.1*	55.3	57.2*	59.0
4	43.4*	44.4*	46.9	50.7	52.4*	55.2*	56.9*	61.4

*Decrease in the average length from the previous quarter.

Table 10: Average weight at age (kilograms) 1971-1985.

	YEAR														
AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
3	0.760	0.352	0.456	0.601	0.481	0.649	0.533	0.400	0.505	0.564	0.503	0.713	0.679	0.772	0.709
4	0.815	0.560	0.667	0.778	0.737	0.745	0.758	0.681	0.706	0.688	0.674	0.756	0.863	0.872	0.824
5	1.115	0.916	0.920	1.078	1.142	1.071	1.249	1.030	1.004	0.919	0.848	0.971	1.126	1.073	0.958
6	1.402	1.331	1.274	1.485	1.763	1.505	1.809	1.661	1.414	1.206	1.132	1.179	1.245	1.508	1.281
7	2.146	1.516	1.683	1.959	2.363	2.170	2.437	2.261	2.213	1.472	1.382	1.448	1.425	1.592	1.653
8	3.681	2.542	2.301	2.677	2.752	2.835	3.513	2.815	3.299	2.643	1.832	1.670	1.596	1.845	1.771
9	3.836	4.922	3.574	2.893	3.221	3.220	4.242	4.354	4.064	2.895	3.150	2.111	1.821	2.126	2.028
10	5.253	5.929	5.507	4.176	3.699	3.867	4.290	4.657	7.134	3.566	4.122	3.077	2.063	2.567	2.266
11	6.010	7.117	6.004	6.065	4.457	4.750	5.074	6.495	7.021	7.958	4.456	3.847	5.245	4.418	2.540
12	4.775	8.051	7.904	7.260	6.961	5.058	5.492	6.551	6.701	5.805	5.603	3.712	6.523	6.198	6.486
13	6.821	8.830	6.150	8.290	9.202	6.238	6.743	6.250	4.698	10.316	6.032	6.880	6.766	8.761	5.313
14	7.457	10.124	6.707	6.600	6.319	10.343	8.977	5.090	8.713	5.813	7.080	9.287	11.380	7.302	6.560
15	7.914	5.599	8.918	9.122	8.390	11.472	10.795	11.566	15.415	9.770	3.490	4.180	14.610	11.295	12.090
16	17.897	11.185	6.047	11.748	6.175	14.301	9.258	10.195	17.396	9.355	6.760	11.100	11.383	13.279	10.290

Table 11: Catch at age (thousands) 1971-1985

	YEAR														
AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
3	6	3177	1337	2731	1556	466	546	538	142	314	96	372	874	82	819
4	2040	22152	6888	4980	8781	3460	3357	9854	4959	2019	3762	1244	3857	3761	4714
5	7082	11824	14327	4774	6761	8930	4115	10627	15531	15000	7277	10101	5665	6205	20320
6	9018	6541	5242	9404	2487	6563	2865	4463	10956	14152	18841	9530	14804	5765	8956
7	5746	7422	3648	2986	3237	1592	1686	2589	3391	9541	12863	12737	7320	9883	5218
8	2276	3467	2736	1795	1293	1138	406	1065	1670	1274	6026	6690	8724	4603	5029
9	1225	919	1803	1702	1104	446	291	237	835	699	867	2157	3327	4898	1829
10	510	529	540	1035	791	265	180	241	291	320	432	326	744	1624	1432
11	129	354	328	266	671	135	124	104	247	124	190	110	50	250	324
12	346	114	97	194	150	140	55	72	64	24	64	58	26	56	33
13	73	49	67	85	53	45	59	44	33	16	81	6	6	19	18
14	117	14	46	26	74	14	11	5	15	8	2	3	1	6	2
15	151	46	11	6	7	10	4	13	15	11	14	2	1	6	0
16	61	36	23	15	66	9	5	6	8	26	3	2	4	7	1
TOTAL	28780	56644	37093	29999	27031	23213	13704	29858	38157	43528	50518	43338	45403	37165	48695

Table 12: Analysis of variance of the multiplicative model.

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R 847
MULTIPLE R SQUARED 717

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	1.324 E0003	1.324 E0003	
REGRESSION	42	7.473 E0002	1779 E0001	88.151
COUNTRY-GEAR TONNAGE	11	1.492 E0002	1.356 E0001	67.188
AREA	1	4.506 E0000	4.506 E0000	22.323
MONTH	11	9.210 E0001	8.372 E0000	41.477
YEAR	19	1.338 E0002	7.044 E0000	34.896
RESIDUALS	1459	2..945 E0002	2.019 E-001	
TOTAL	1502	2.366 E0003		

Table 13: Regression coefficients of the multiplicative model.

CATEGORY			COEFFICIENT	STD. ERROR	NO. OBS.
*Country-Gear -Tonnage					
-M-Q	OTB-1	TC-3	0.421	0.043	217
-M-Q	OTB-1	TC-4	1.131	0.054	165
-M-Q	OTB-2	TC-2	0.722	0.125	22
-M-Q	OTB-2	TC-3	0.607	0.053	153
-M-Q	OTB-2	TC-4;N OTB-1 TC-4	1.034	0.055	203
-M-Q-N	OTB-2	TC-5	1.335	0.059	169
-M-Q	SDN	TC-2	0.400	0.051	131
-M-Q	SDN	TC-3	0.804	0.053	112
-M-Q	SSC	TC-2	0.616	0.134	17
-M-Q	SSC	TC-3	0.886	0.063	90
-M-Q	LL	TC-2	0.684	0.068	76
Area		4Vn	-0.221	0.047	335
Month		February	0.115	0.059	114
		March	-0.215	0.069	75
		April	-0.547	0.053	193
		May	-0.817	0.061	164
		June	-0.947	0.066	129
		July	-1.034	0.069	104
		August	-1.158	0.069	104
		September	-1.157	0.070	100
		October	-1.098	0.068	112
		November	-0.911	0.065	139
		December	-0.576	0.066	116
Year		1967	0.088	0.098	48
		1968	0.400	0.098	49
		1969	0.395	0.091	75
		1970	0.219	0.091	73
		1971	0.101	0.087	94
		1972	0.229	0.088	84
		1973	0.033	0.090	84
		1974	-0.191	0.092	66
		1975	-0.184	0.095	57
		1976	-0.149	0.093	64
		1977	-0.091	0.096	58
		1978	0.348	0.094	62
		1979	0.604	0.087	96
		1980	0.642	0.089	90
		1981	0.739	0.088	94
		1982	0.640	0.087	102
		1983	0.882	0.092	85
		1984	0.648	0.087	111
		1985	0.710	0.092	74

* M = Maritimes
  Q = Quebec
  N = Newfoundland

Table 14: Catch rate predicted from the multiplicative model.

STANDARDS USED: Maritimes-Quebec, OTB-1, TC-2 in 4T in January

YEAR	TOTAL CATCH	PROP.	MEAN	S.E.	EFFORT
66	54851	0.234	0.321	0.032	171091
67	41316	0.368	0.350	0.031	117895
68	46551	0.405	0.479	0.042	97213
69	47819	0.493	0.477	0.039	100298
70	64465	0.370	0.400	0.032	161326
71	56375	0.473	0.355	0.028	158642
72	65291	0.484	0.404	0.032	161695
73	50635	0.360	0.332	0.027	152634
74	48747	0.311	0.265	0.022	183717
75	42471	0.356	0.267	0.023	159013
76	33415	0.519	0.277	0.023	120753
77	22219	0.519	0.352	0.030	63175
78	37892	0.524	0.455	0.038	83306
79	55996	0.594	0.588	0.046	95287
80	54634	0.558	0.610	0.048	89515
81	65177	0.519	0.673	0.052	96914
82	58193	0.566	0.609	0.047	95497
83	61295	0.464	0.776	0.063	79001
84	59360	0.610	0.614	0.046	96676
85	61112	0.454	0.653	0.053	93544

AVERAGE C.V. FOR THE MEAN: .083

Table 15: Results of a multiplicative model on the Quebec fleet data (1979-1986)

Regression of Multiplicative Model

Multiple R ..... .730
Multiple R Squared ..... .534

Analysis of Variance

Source of Variation	DF	Sums of Squares	Means Squares	F-Value
Intercept	1	1.683E0002	1.683E0002	
Regression	15	1.011E0001	6.741E⁻001	7.778
Gear-Tonnage	4	6.822E0000	1.706E0000	19.681
Month	4	1.387E0000	3.468E⁻001	4.002
Year	7	1.179E0000	1.684E⁻001	1.943
Residuals	102	8.840E0000	8.666E⁻002	
Total	118	1.873E0002		

Regression coefficients

Category	Coefficient	Std. Error	No. Obs.
Gear Tonnage			
OTB-1 TC-3	0.237	0.068	38
OTB-2 TC-3	0.263	0.070	35
SDN TC-3	1.044	0.171	4
LL TC-2	⁻0.799	0.172	4
Month			
May	0.175	0.093	26
June	0.196	0.093	26
July	0.078	0.093	26
August	⁻0.098	0.095	23
80	⁻0.199	0.110	14
81	⁻0.060	0.107	19
82	0.104	0.110	18
83	0.066	0.112	13
84	⁻0.071	0.110	14
85	0.012	0.107	15

Table 16: 4TVn cod population numbers estimates from E.E. Prince fall groundfish survey 1971-1985.

AGE	YEAR														
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
0	0	0	43	0	0	0	21	0	278	486	386	431	232	527	255
1	119	1479	146	160	806	6050	1105	2366	337	1977	9555	5339	9613	646	8462
2	1149	4195	9499	4673	10987	14850	20639	9711	43894	9331	41526	68487	37249	14767	27620
3	12514	9200	18830	20452	8267	64271	30628	43942	44550	64799	38540	51257	137358	38124	65385
4	15144	24563	8731	14345	12511	16153	25823	47345	94472	48661	114948	37710	53349	92968	62849
5	14387	10177	13901	5555	10489	10815	10107	26758	57644	84714	95243	77032	19333	44997	104828
6	11178	8458	6551	6704	3693	4559	5360	8143	23502	41587	92946	37802	33736	14330	32956
7	7066	5767	4641	2902	2639	1206	3058	4594	6137	15001	39109	28748	19280	18601	7839
8	1718	3345	3494	2044	1768	895	1317	1569	2518	2495	21071	13644	15351	7655	9127
9	328	622	2211	2055	820	503	970	627	1258	1211	2786	1969	3870	8915	3222
10	387	471	620	882	598	475	622	785	336	506	1163	675	1129	2780	2972
11	216	407	146	356	712	417	504	910	370	121	514	249	477	654	550
12	174	128	424	175	168	124	405	110	310	24	209	88	129	81	64
13	9	66	60	377	91	125	492	0	93	15	126	73	74	109	33
14	164	33	98	0	0	35	0	242	89	94	99	0	0	59	0
15	144	60	27	82	0	0	83	58	88	15	112	0	0	15	32
16+	314	72	322	214	0	39	143	0	36	30	166	137	0	106	0
0+	65011	69043	69744	60976	53549	120517	101277	147160	275912	271067	458499	323641	331180	245334	326194
1+	65011	69043	69701	60976	53549	120517	101256	147160	275634	270581	458113	323210	330948	244807	325939
2+	64892	67564	69555	60816	52743	114467	100151	144794	275297	268604	448558	317871	321335	244161	317477
3+	63743	63369	60056	56143	41756	99617	79512	135083	231403	259273	407032	249384	284086	229394	289857
4+	51229	54169	41226	35691	33489	35346	48884	91141	186853	194474	368492	198127	146728	191270	224472
5+	36085	29606	32495	21346	20978	19193	23061	43796	92381	145813	253544	160417	93379	98302	161623
6+	21698	19429	18594	15791	10489	8378	12954	17038	34737	61099	158301	83385	74046	53305	56795
7+	10520	10971	12043	9087	6796	3819	7594	8895	11235	19512	65355	45583	40310	38975	23839

Table 17 Result of the survivor analysis for the period 1979-1985 (Underlined residuals are outliers)

INTEGRATED CATCH

I	1979	1980	1981	1982	1983	1984	1985
3	65747	82606	32192	30533	35425	5810	431
4	109807	52807	65707	25723	23003	26838	2479
5	69829	80712	38903	47370	17829	14220	10685
6	32825	43751	50659	24184	27391	9415	4710
7	5556	17818	23807	27304	12214	11350	2744
8	2689	2483	7449	10606	12720	4658	2845
9	1234	1150	1072	2478	4221	4328	982
0	411	498	435	349	746	1250	753
1	280	152	160	118	122	172	170
2	53	112	41	38	37	51	17
3	17	6	43	3	3	10	9

INTEGRATED SURVIVORS

I	1979	1980	1981	1982	1983	1984	1985
3	0	14053	7931	41332	111654	55781	88158
4	0	5513	11505	6494	33840	91415	45670
5	0	5274	4514	9420	5317	27706	74844
6	0	955	4318	3696	7712	4353	22684
7	73	123	782	3538	3028	6314	3564
8	207	60	100	640	2895	2477	5170
9	109	169	49	82	524	2970	2028
0	71	89	138	40	67	429	1940
1	3	58	73	113	33	55	351
2	7	2	48	60	93	27	45
3	66	6	2	39	49	76	22

POPULATION NUMBERS

I	1979	1980	1981	1982	1983	1984	1985
3	65747	98659	40123	71865	147080	61591	88587
4	109907	58320	77212	32217	56843	118253	48149
5	69829	85987	43417	56790	23146	41928	85529
6	32825	44708	54977	27879	35103	13768	27393
7	5630	17741	24389	30839	15240	17684	6308
8	2896	2543	7550	11247	15815	7135	7814
9	1343	1319	1121	2561	4745	6698	2990
10	482	587	574	389	814	1679	2693
11	283	211	253	231	155	227	522
12	80	114	89	98	130	78	62
13	83	14	44	42	52	88	32

ESTIMATED SURVIVORS

I	1979	1980	1981	1982	1983	1984	1985
3	0	1708	8128	19301	91316	33936	79716
4	0	0	22098	8784	19844	52050	57152
5	0	0	18824	10697	0	19288	75185
6	0	0	13209	4784	1692	2522	22415
7	0	0	4627	0	3053	3919	3863
8	0	0	4635	794	614	1822	4995
9	0	0	578	0	0	2702	1738
10	0	0	300	128	180	916	1724
11	31	0	170	64	185	308	291
12	166	0	108	30	58	18	36
13	60	5	63	56	57	79	18

RESIDUALS

I	1979	1980	1981	1982	1983	1984	1985
3	-0.0881	-0.0988	0.2628	-0.0349	0.2347	-0.1766	-0.0006
4	-0.1079	-0.1376	0.4414	0.2009	-0.0200	-0.1971	0.3099
5	-0.3032	-0.1263	0.8742	0.1935	-0.2914	-0.0407	0.0921
6	-0.4455	-0.1837	0.4137	0.1931	-0.1511	-0.0714	0.0735
7	-0.0251	-0.2781	0.3808	-0.1816	0.1238	-0.0597	0.1059
8	-0.2512	-0.1305	0.9150	0.0818	-0.1284	-0.0411	0.0439
9	-0.1764	-0.1971	0.7990	-0.3741	-0.3152	0.1748	-0.0367
10	-0.4732	-0.2806	0.5952	0.4388	0.2161	0.3926	-0.0130
11	0.1564	-0.6662	0.5983	-0.0381	1.0147	0.9471	-0.0585
12	1.5291	-1.6895	0.7457	-0.2145	-0.1170	-0.0798	-0.0870
13	-0.0002	-0.0454	0.9304	0.4384	0.2405	0.1259	-0.0874

MEAN OF RESIDUALS=7.3736379E-2
STANDARD DEVIATION OF RESIDUALS=0.43254839

ESTIMATED VARIANCE OF SURVIVORS (x 10E-5)

I	1979	1980	1981	1982	1983	1984	1985
3	425	1342	708	1869	20018	2301	9013
4	1138	450	3748	602	1797	8140	4955
5	311	1001	1868	1842	173	1399	10113
6	48	215	1805	398	471	127	1000
7	3	28	284	229	154	213	57
8	1	1	82	52	97	38	77
9	0	0	1	1	6	49	10
10	0	0	0	0	1	5	8
11	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0

WEIGHTED SURVIVORS

I	1979	1980	1981	1982	1983	1984	1985
3	0	59	333	3680	16791	23178	79716
4	0	0	275	327	3934	23536	16121
5	0	0	68	271	0	4911	27363
6	0	0	51	82	168	578	7989
7	0	0	4	0	136	858	1984
8	0	0	0	4	39	306	3043
9	0	0	0	0	0	343	1242
10	0	0	3	1	1	48	1321
11	0	0	4	11	2	4	262
12	1	0	9	15	24	3	35
13	60	5	1	28	28	31	14

RMS=0.13484358

ESTIMATED SURVIVORS FOR AGE 13 (WEIGHTED)

YEAR	SURVIVORS	STANDARD ERROR	C.V. (PERCENT)
1979	60	28	47.36
1980	5	5	89.23
1981	2	6	348.56
1982	35	15	42.76
1983	44	15	34.30
1984	89	21	29.98
1985	20	9	44.44

ESTIMATED SURVIVORS FOR 1985 (WEIGHTED)

AGE	SURVIVORS	STANDARD ERROR	C.V. (PERCENT)
3	79716	30022	37.66
4	41297	12534	30.35
5	67690	19185	28.34
6	20515	5969	29.09
7	3223	1704	52.88
8	4675	2161	46.23
9	1834	828	45.04
10	1755	789	44.97
11	318	158	49.79
12	41	19	46.99
13	20	9	44.44

FINAL ESTIMATION FOR K

AGE	K	LN(K)	VAR(LN(K))	STANDARD ERROR	D.F
3	1.35	0.2859	0.0343	0.0756	5
4	1.04	0.0135	0.0599	0.0999	5
5	0.89	-0.1216	0.0205	0.0292	23
6	0.89	-0.1216	0.0205	0.0292	23
7	0.89	-0.1216	0.0205	0.0292	23
8	0.89	-0.1216	0.0205	0.0292	23
9	0.89	-0.1216	0.0205	0.0292	23
10	0.89	-0.1216	0.0205	0.0292	23
11	0.89	-0.1216	0.0205	0.0292	23
12	0.89	-0.1216	0.0205	0.0292	23
13	0.89	-0.1216	0.0205	0.0292	23

Table 18. Partial recruitment vectors for the 4TVn cod fishery in 1985.

Age	1981-1984 Historical Average	Mean 1983-1985 Catch/R.V. (RNFS)
1	0.000	0.000
2	0.000	0.000
3	0.002	0.017
4	0.030	0.117
5	0.139	0.242
6	0.317	0.592
7	0.469	0.868
8	0.661	1.000
9	0.821	1.000
10	1.000	1.000
11	1.000	1.000
12	1.000	1.000
13	1.000	1.000
14	1.000	1.000
15	1.000	1.000
16	1.000	1.000

Table 19. Calibration results for the SPA.

	F	Intercept	R^2	RESIDUALS 83	84	85	$\sum_{83}^{85}$ (observed-expected)/expected
4+ Mean Population	0.30	-50718	0.624	-94498	155319	154025	0.688
biomass vs CPUE	0.35	-28807	0.668	-85990	123221	113352	0.496
(1971-1985)	0.40	-12383	0.704	-79605	99146	82838	0.360
	0.45	381	0.731	-74634	80422	59095	0.264
	0.50	10582	0.747	-70652	65447	40090	0.196
	0.55	18920	0.751	-67390	53200	24532	0.150
	0.60	25859	0.744	-64668	42999	11558	0.119
	0.65	31723	0.727	-62360	34374	572	0.101
	0.70	36741	0.703	-60378	26988	-8852	0.092
	0.75	41083	0.672	-58657	20593	-17028	0.089
	0.80	44875	0.639	-57147	15004	-24188	0.092
5+ Mean Population							
biomass vs CPUE	0.30	-26778	0.637	-61602	28270	133652	0.539
(1971-1985)	0.35	-13089	0.682	-55787	16721	100041	0.364
	0.40	-2829	0.715	-51422	8054	74827	0.247
	0.45	5146	0.735	-48023	1313	55210	0.169
	0.50	11519	0.740	-45298	-4080	39510	0.120
	0.55	16728	0.732	-43065	-8489	26659	0.090
	0.60	21062	0.713	-41199	-12161	15944	0.074
	0.65	24724	0.687	-39617	-15263	6872	0.069
	0.70	27858	0.655	-38257	-17917	-909	0.071
	0.75	30568	0.621	-37074	-20213	-7658	0.078
	0.80	32935	0.586	-36036	-22216	-13568	0.090
6+ Mean Population	0.30	-1016	0.673	-11910	25857	34555	0.143
biomass vs CPUE	0.35	6349	0.677	-10302	17934	19845	0.066
(1971-1985)	0.40	11870	0.662	-9092	11985	8809	0.026
	0.45	16161	0.632	-8148	7356	224	0.010
	0.50	19590	0.593	-7389	3651	-6648	0.010
	0.55	22393	0.551	-6764	662	-12274	0.020
	0.60	24725	0.508	-6240	-1901	-16965	0.036
	0.65	26694	0.466	-5793	-4032	-20938	0.057
	0.70	28379	0.428	-5407	-5856	-24346	0.080
	0.75	29836	0.393	-5070	-7433	-27303	0.104
	0.80	31108	0.362	-4772	-8808	-29894	0.129

continued/...

Table 19. Calibration results for the SPA. (Continued)

	F	Intercept	R^2	RESIDUALS 83	RESIDUALS 84	RESIDUALS 85	$\sum_{83}^{85} \frac{(\text{observed-expected})^2}{\text{expected}}$
4+ SPA Mean	0.30	283026	0.000	-53062	112773	139896	0.447
Population Numbers	0.35	251822	0.001	-48666	86820	102494	0.310
vs	0.40	228429	0.006	-45363	67357	74432	0.212
Research Population	0.45	210242	0.018	-42787	52220	52595	0.145
Numbers	0.50	195702	0.040	-40720	40114	35115	0.099
(1979-1985)	0.55	183815	0.070	-39024	30212	20804	0.070
	0.60	173918	0.097	-37605	21964	8870	0.053
	0.65	165552	0.114	-36399	14988	-1237	0.045
	0.70	158389	0.120	-35360	9013	-9907	0.044
	0.75	152189	0.120	-34456	3839	-17429	0.049
	0.80	146772	0.116	-33661	-685	-24017	0.057
5+ SPA Mean	0.30	133659	0.048	-16890	-2704	117722	0.505
Population Numbers	0.35	121431	0.081	-15355	-8100	88734	0.339
vs	0.40	112264	0.130	-14199	-12149	66987	0.227
Research Population	0.45	105139	0.190	-13295	-15297	50068	0.153
Numbers	0.50	99444	0.254	-12566	-17816	36527	0.106
(1979-1985)	0.55	94790	0.304	-11966	-19875	25444	0.078
	0.60	90918	0.332	-11461	-21589	16202	0.064
	0.65	87648	0.335	-11030	-23038	8379	0.059
	0.70	84850	0.324	-10657	-24278	1668	0.062
	0.75	82431	0.304	-10330	-25350	-4151	0.070
	0.80	80320	0.283	-10040	-26286	-9247	0.082
6+ SPA Mean	0.30	61682	0.262	12814	6682	23706	0.132
Population Numbers	0.35	54745	0.447	11587	3620	14933	0.072
vs	0.40	49541	0.617	10670	1322	8351	0.039
Research Population	0.45	45494	0.729	9960	-466	3231	0.024
Numbers	0.50	42257	0.783	9395	-1896	-867	0.021
(1979-1985)	0.55	39610	0.797	8937	-3065	-4222	0.028
	0.60	37405	0.788	8558	-4038	-7020	0.039
	0.65	35541	0.769	8242	-4859	-9390	0.055
	0.70	33944	0.747	7973	-5561	-11423	0.073
	0.75	32562	0.725	7744	-6167	-13187	0.093
	0.80	31354	0.704	7546	-6695	-14732	0.114

. Table 20 . 4TVn cod population numbers ('000) with F_t = 0.65

POPULATION NUMBERS

	1971	1972	1973	1974	1975	1976	1977	1978	1979
3	87476	34022	45534	51749	39569	98244	141629	157454	79213
4	38711	71614	24990	36073	39904	30992	80014	115463	128426
5	30662	29853	38759	14275	25048	24775	22255	62480	85646
6	30517	18737	13860	18901	7407	14436	12284	14518	41588
7	19040	16892	9479	6654	7088	3835	5957	7482	7882
8	5850	10433	7197	4495	2780	2912	1716	3363	3805
9	3246	2752	5433	3443	2074	1122	1366	1040	1798
10	1645	1561	1430	2832	1301	715	519	857	638
11	562	889	804	687	1391	363	348	264	485
12	854	344	411	364	324	540	176	174	123
13	194	389	179	249	126	132	317	95	78
14	334	94	275	87	128	55	67	206	38
15	360	168	64	183	48	39	33	45	164
16	154	160	97	43	145	33	23	23	25
3+	219604	187908	148511	140036	127333	178192	266704	363463	349911
4+	132128	153886	102977	88287	87764	79948	125075	206009	270698
5+	93417	82272	77987	52214	47860	48957	45061	90547	142271
6+	62756	52419	39228	37938	22813	24182	22806	28067	56625

	1980	1981	1982	1983	1984	1985
3	106801	52041	71797	164151	86730	82214
4	64726	87157	42520	58447	133606	70934
5	100670	51170	67963	33690	44372	105992
6	56143	68912	35340	46546	22483	30739
7	24208	33251	39501	20375	24830	13228
8	3422	11281	15709	20918	10124	11485
9	1623	1661	3870	6880	9324	4177
10	727	704	587	1249	2664	3270
11	263	309	193	191	362	740
12	177	105	84	60	111	75
13	44	123	29	18	26	41
14	34	21	29	18	9	5
15	18	21	16	21	14	2
16	121	5	5	11	16	6
3+	358976	309761	277643	352574	334672	322910
4+	252175	254720	205846	188423	247942	240696
5+	187450	167563	163325	129977	114336	169762
6+	86779	116392	95362	96287	69964	63770

Table 21. 4TVn cod mean population biomass (t) with F_t = 0.65

MEAN POPULATION BIOMASS (METRIC TONS)

	1971	1972	1973	1974	1975	1976	1977	1978	1979
3	60253	10316	18505	27393	16901	57634	68327	56960	36257
4	27800	29953	12758	23517	23392	19648	53743	67967	80423
5	26988	19083	25430	11285	21994	19069	22622	52850	70125
6	32302	18081	12510	17886	9565	14418	17518	18043	45414
7	30697	17228	11244	8697	11093	5717	11059	12296	11828
8	15123	19483	11716	8380	5028	5791	4743	7038	8449
9	8828	9939	14268	6366	4110	2519	4630	3583	4807
10	6452	6762	5580	8463	2717	1970	1619	3042	3019
11	2669	4410	3334	2930	4010	1227	1273	1199	2144
12	2824	2036	2557	1628	1487	2117	722	782	513
13	940	2901	785	1509	790	598	1736	390	249
14	1802	789	1515	432	473	446	499	939	235
15	1953	723	469	1489	335	347	300	397	2181
16	1919	1419	459	361	592	360	169	184	328
3+	220551	143122	121130	120337	102486	131863	188958	225670	265974
4+	160298	132807	102624	92944	85585	74229	120631	168710	229717
5+	132498	102854	89866	69426	62193	54581	66888	100743	149294
6+	105510	83771	64436	58142	40199	35512	44266	47893	79169

	1980	1981	1982	1983	1984	1985
3	54531	23712	46292	100733	60654	52549
4	39691	51992	28694	44088	104000	51076
5	77013	36266	54945	31201	39851	82276
6	52696	59834	32036	43025	26312	29315
7	24919	32323	42327	20886	27556	15288
8	6438	12688	17861	22900	12393	13702
9	3185	3252	4893	8092	12284	5706
10	1742	1627	1085	1477	3869	4992
11	1366	772	438	773	807	1266
12	861	329	159	266	437	329
13	322	393	159	89	108	147
14	157	130	231	182	36	20
15	99	38	55	273	107	19
16	903	19	35	97	148	42
3+	263924	223377	229212	274082	288564	257228
4+	209393	199665	182919	173349	227909	204679
5+	169701	147673	154225	129261	123909	153603
6+	92688	111406	99280	98060	84058	71326

Table 22. 4TVn cod fishing mortalities with F_t = 0.65

FISHING MORTALITY

I	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	198
3 I	0.000	0.109	0.033	0.060	0.044	0.005	0.004	0.004	0.002	0.003	0.002	0.00
4 I	0.060	0.414	0.360	0.165	0.277	0.131	0.047	0.099	0.044	0.035	0.049	0.03
5 I	0.292	0.567	0.518	0.456	0.351	0.502	0.227	0.207	0.222	0.179	0.170	0.17
6 I	0.391	0.481	0.534	0.781	0.458	0.685	0.296	0.411	0.341	0.324	0.357	0.35
7 I	0.402	0.653	0.546	0.673	0.689	0.604	0.372	0.476	0.634	0.564	0.550	0.43
8 I	0.554	0.452	0.537	0.573	0.708	0.557	0.301	0.426	0.652	0.523	0.870	0.62
9 I	0.532	0.455	0.452	0.773	0.865	0.570	0.267	0.288	0.706	0.635	0.840	0.93
0 I	0.415	0.464	0.533	0.511	1.077	0.520	0.477	0.369	0.688	0.655	1.094	0.92
1 I	0.291	0.571	0.591	0.551	0.746	0.522	0.494	0.564	0.809	0.722	1.097	0.96
2 I	0.585	0.451	0.300	0.865	0.702	0.334	0.419	0.603	0.836	0.162	1.090	1.35
3 I	0.529	0.149	0.525	0.467	0.618	0.469	0.229	0.704	0.622	0.512	1.242	0.26
4 I	0.484	0.180	0.204	0.397	0.988	0.324	0.198	0.027	0.556	0.296	0.109	0.12
5 I	0.612	0.356	0.209	0.037	0.176	0.330	0.144	0.378	0.106	1.082	1.295	0.15
6 I	0.569	0.284	0.303	0.488	0.688	0.357	0.274	0.332	0.424	0.269	1.050	0.63
8+I	0.522	0.449	0.496	0.610	0.810	0.526	0.322	0.395	0.668	0.560	0.887	0.69

I	1983	1984	1985
3 I	0.006	0.001	0.011
4 I	0.075	0.032	0.076
5 I	0.204	0.167	0.237
6 I	0.428	0.330	0.385
7 I	0.499	0.571	0.564
8 I	0.608	0.685	0.650
9 I	0.749	0.848	0.650
.0 I	1.039	1.081	0.650
11 I	0.339	1.369	0.650
12 I	0.638	0.795	0.650
13 I	0.457	1.540	0.650
14 I	0.063	1.202	0.650
15 I	0.054	0.633	0.650
16 I	0.353	0.627	0.650
8+I	0.657	0.811	0.650

Table 23. Results of the Schaefer general production model with fishing effort averaged over 3 years

CATCH	EFFORT	CPUE
54851	171096	0.321
41316	117895	0.350
46551	97213	0.479
47819	100298	0.477
64465	161326	0.400
56375	158642	0.355
65291	161695	0.404
50635	152634	0.332
48747	183717	0.265
42471	159013	0.267
33415	120753	0.277
22219	63175	0.352
37892	83306	0.455
55996	95287	0.588
54634	89515	0.610
65177	96914	0.673
58193	95497	0.609
61295	79001	0.776
59360	96676	0.614
61112	93544	0.653

FISHING EFFORT IS AVERAGED OVER 3 YEARS

LINEAR REGRESSION STATISTICS

	ESTIMATES	VARIANCES	STAND. ERROR
ORIGIN(A)	9.8253365E-1	6.4682846E-3	8.0425647E-2
SLOPE(B)	-4.2741492E-6	4.3374348E-13	6.5859204E-7
COVAR(A,B)		-5.13081590E-8	
CPUE AT MSY		0.4913	
FISHING EFFORT GIVING MSY		114939.092	
MAXIMUM SUSTAINABLE YIELD		56465.7626	

MEAN EFFORT	CPUE(OBSERVED)	CPUE(CALCULATED)	RESIDUALS
128735	0.48	0.43	0.047
105135	0.48	0.53	-0.056
119612	0.40	0.47	-0.072
140089	0.36	0.38	-0.028
160554	0.40	0.30	0.107
157657	0.33	0.31	0.023
166015	0.27	0.27	-0.008
165121	0.27	0.28	-0.010
154494	0.28	0.32	-0.045
114314	0.35	0.49	-0.142
89078	0.45	0.60	-0.147
80589	0.59	0.64	-0.050
89369	0.61	0.60	0.010
93905	0.67	0.58	0.091
93975	0.61	0.58	0.029
90471	0.78	0.60	0.180
90391	0.61	0.60	0.018
89740	0.65	0.60	0.054

Table 24 Input parameters used for the 1987 catch projections.

AGE	1985 POPULATION NUMBERS	1985 CATCH NUMBERS	1983 - 1985 AVERAGE WEIGHTS	PARTIAL RECRUITMENT
3	77000	819	0.720	0.017
4	70934	4714	0.853	0.117
5	105992	20320	1.052	0.364
6	30739	8956	1.345	0.592
7	13228	5218	1.557	0.868
8	11485	5029	1.737	1.000
9	4177	1829	1.992	1.000
10	3270	1432	2.302	1.000
11	740	324	4.068	1.000
12	75	33	6.402	1.000
13	41	18	6.947	1.000
14	5	2	8.414	1.000
15	2	1	12.665	1.000
16	6	1	11.651	1.000

Table 25 4TVn (Jan-Apr) cod projections assuming a 1986 catch of 60,000 t.

	Catch Numbers		Population Numbers		Catch Biomass		Population Biomass		Fishing Mortality	
Age	('000)		('000)		(t)		(t)			
	86	87	86	87	86	87	86	87	86	87
3	676	238	77000	77000	487	171	50012	50165	0.010	0.003
4	3661	1309	62303	62432	3123	1117	46642	47725	0.067	0.023
5	9204	3040	53823	47706	9683	3198	46488	43923	0.208	0.073
6	17939	3628	68495	35781	24128	4880	71225	41216	0.339	0.118
7	6127	5789	17129	39965	9540	9014	19208	51924	0.497	0.174
8	2456	1407	6160	8534	4266	2444	7455	12218	0.572	0.200
9	1957	469	4909	2846	3899	935	6813	4673	0.572	0.200
10	712	374	1785	2268	1639	861	2863	4303	0.572	0.200
11	557	136	1398	825	2267	553	3962	2765	0.572	0.200
12	126	106	316	646	807	681	1411	3407	0.572	0.200
13	13	24	32	146	89	167	156	837	0.572	0.200
14	7	2	18	15	59	21	103	103	0.572	0.200
15	1	1	2	8	10	17	17	85	0.572	0.200
16	0	0	1	1	5	2	8	9	0.572	0.200
3+	43436	16523	293371	278172	60000	24059	256363	263353	0.192	0.070
4+	42760	16285	216371	201172	59513	23888	206351	213188		
5+	39099	14976	154068	138740	56391	22771	159709	165463		
6+	29895	11936	100245	91034	46708	19574	113221	121540		

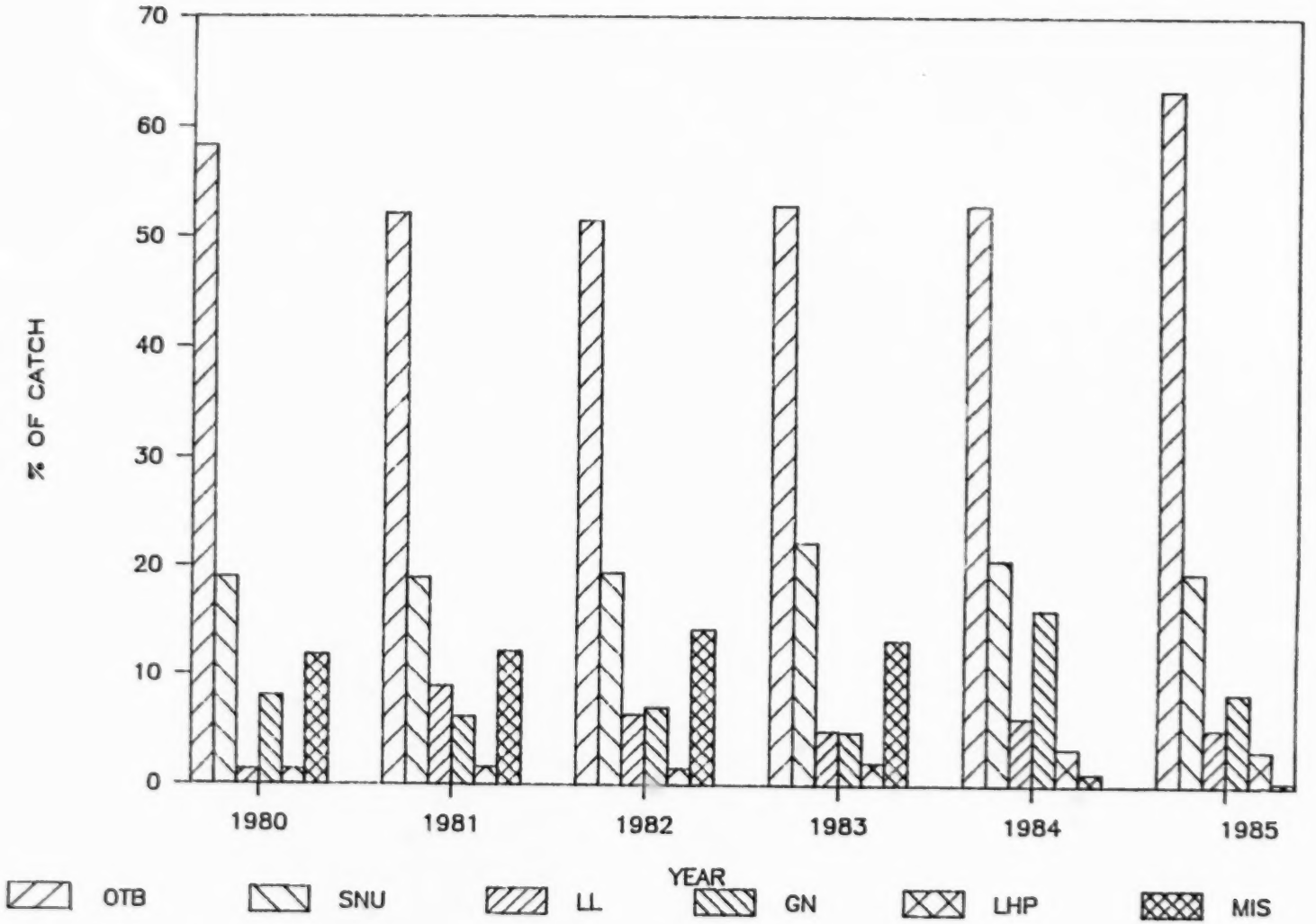


Figure 1: Percent of catch by gear 1980-1985 (OTB: otter trawl; SNU: Danish and Scottish seines; LL: longlines; GN: gillnets; LHP: handlines; MIS: miscellaneous and unknown gear)

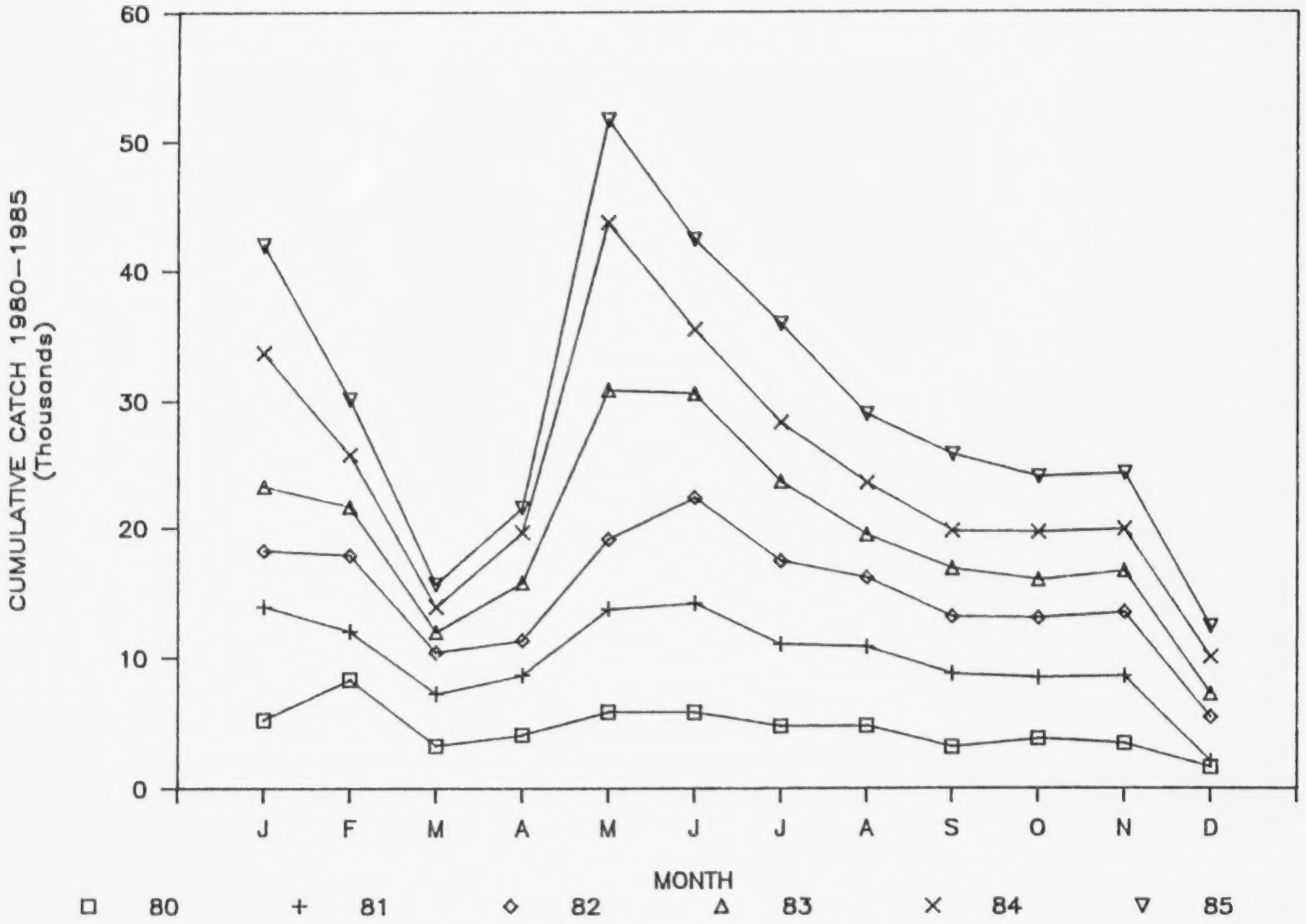


Figure 2: Cumulative cod catch by month in 4TVn (Jan-Apr) 1980-1985

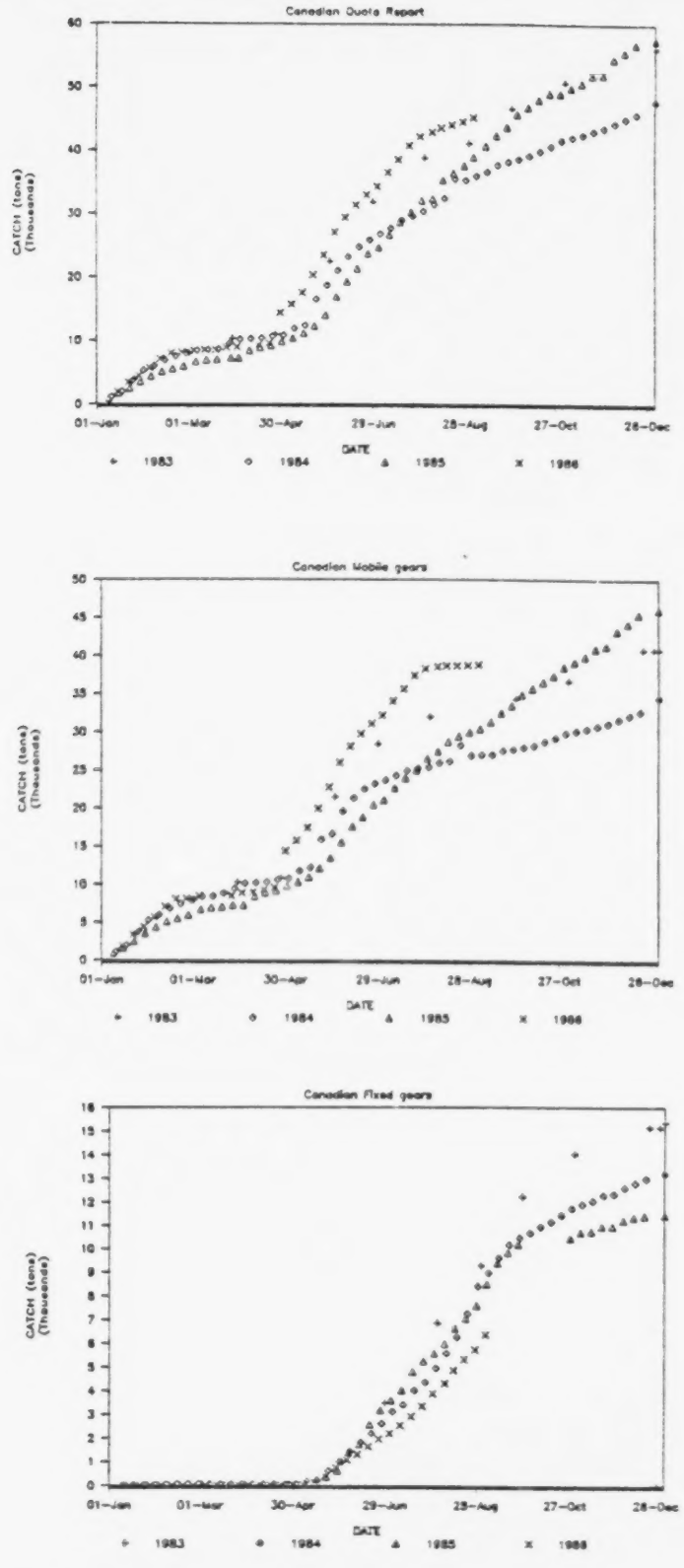


Figure 3 . Canadian landings of cod in 4TVn 1983-1986 (to date) (Source: Canadian Atlantic Quota Reports).

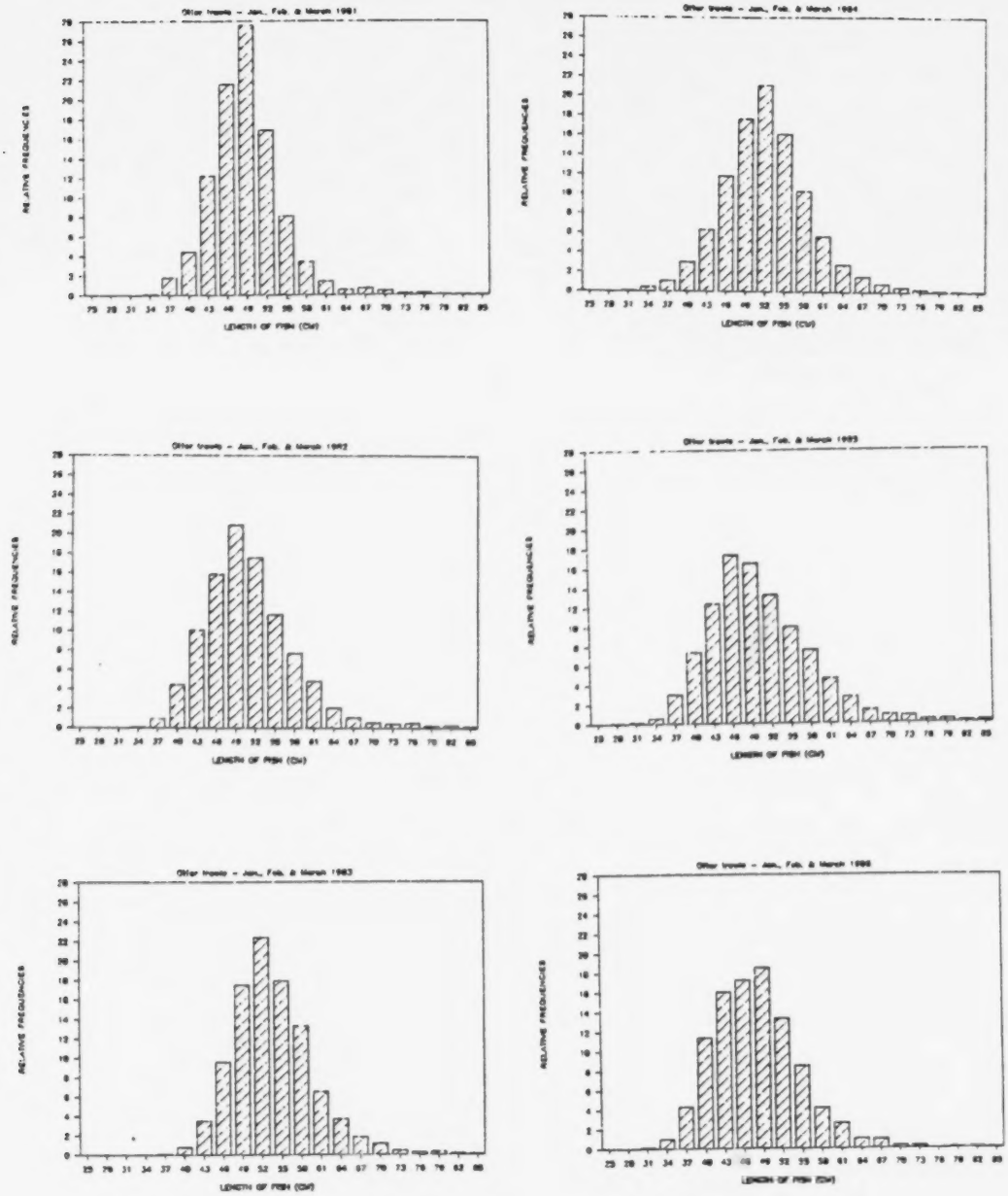


Figure 4 . Relative frequency distributions for otter trawls in January, February, March (1981-1986).

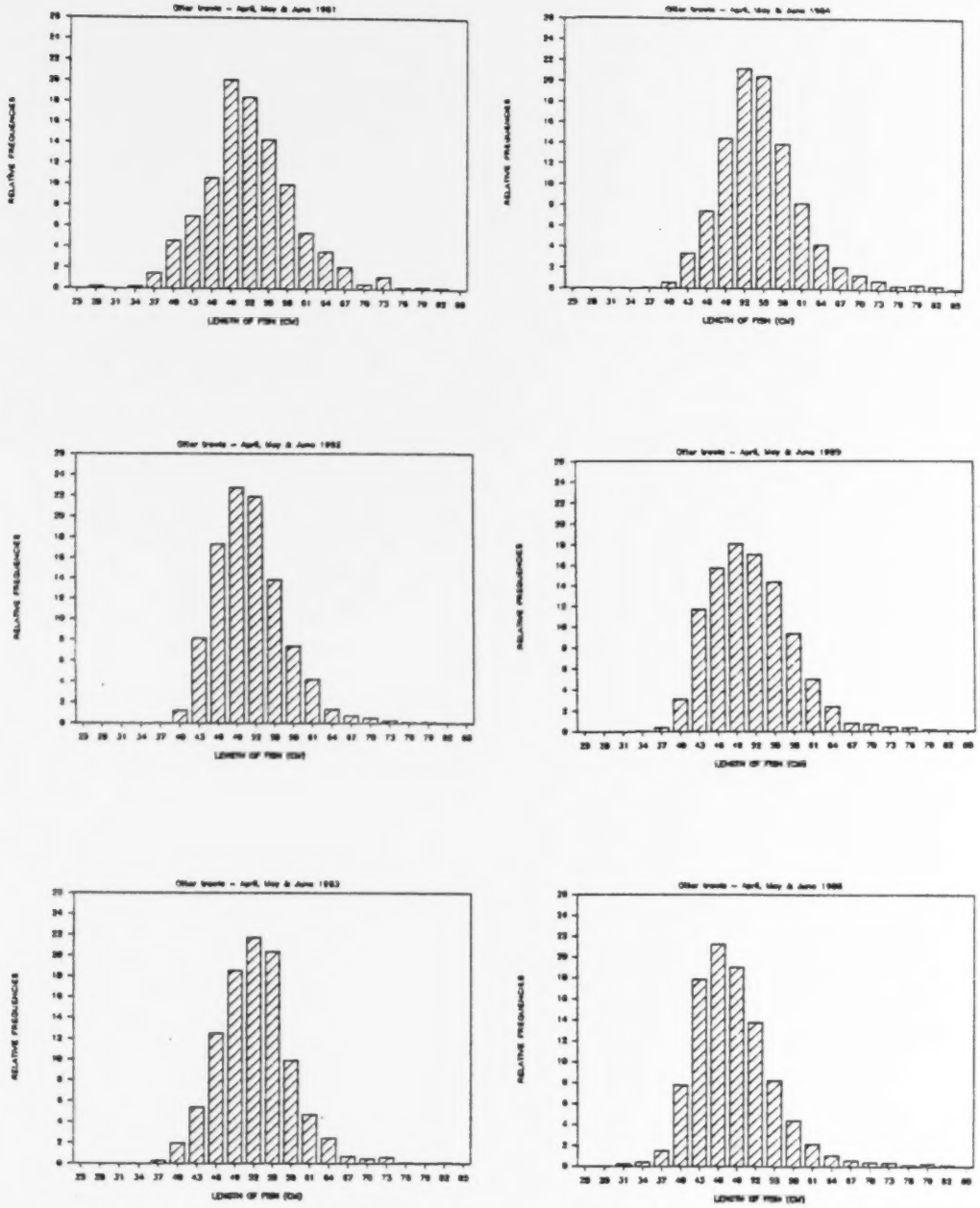


Figure 5 Relative frequency distributions for otter trawls in April, May, June (1981-1986).

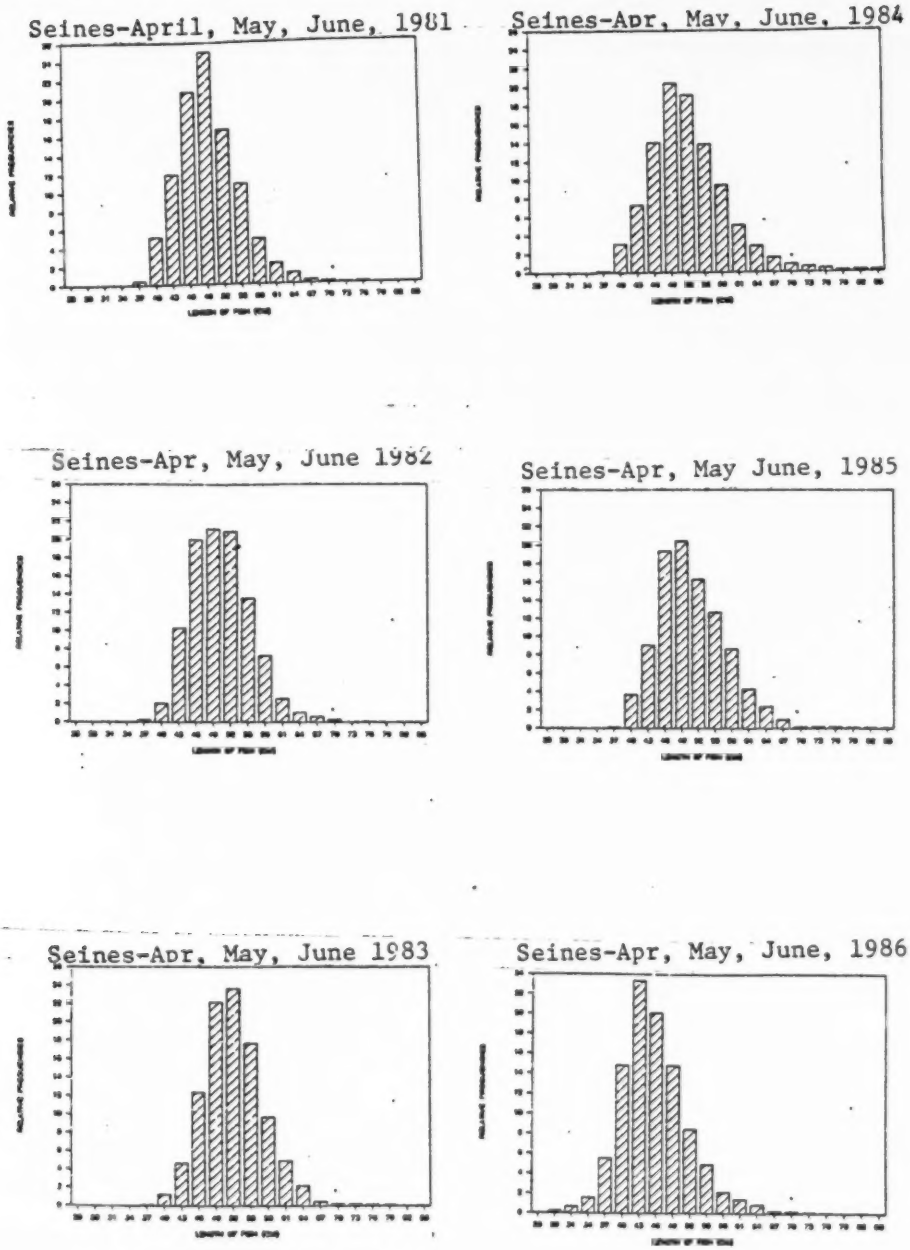

Seines-April, May, June, 1981
Seines-Apr, May, June, 1984
Seines-Apr, May, June 1982
Seines-Apr, May June, 1985
Seines-Apr, May, June 1983
Seines-Apr, May, June, 1986

Figure 6 . Relative frequency distributions of seines in April, May and June (1981-1986).

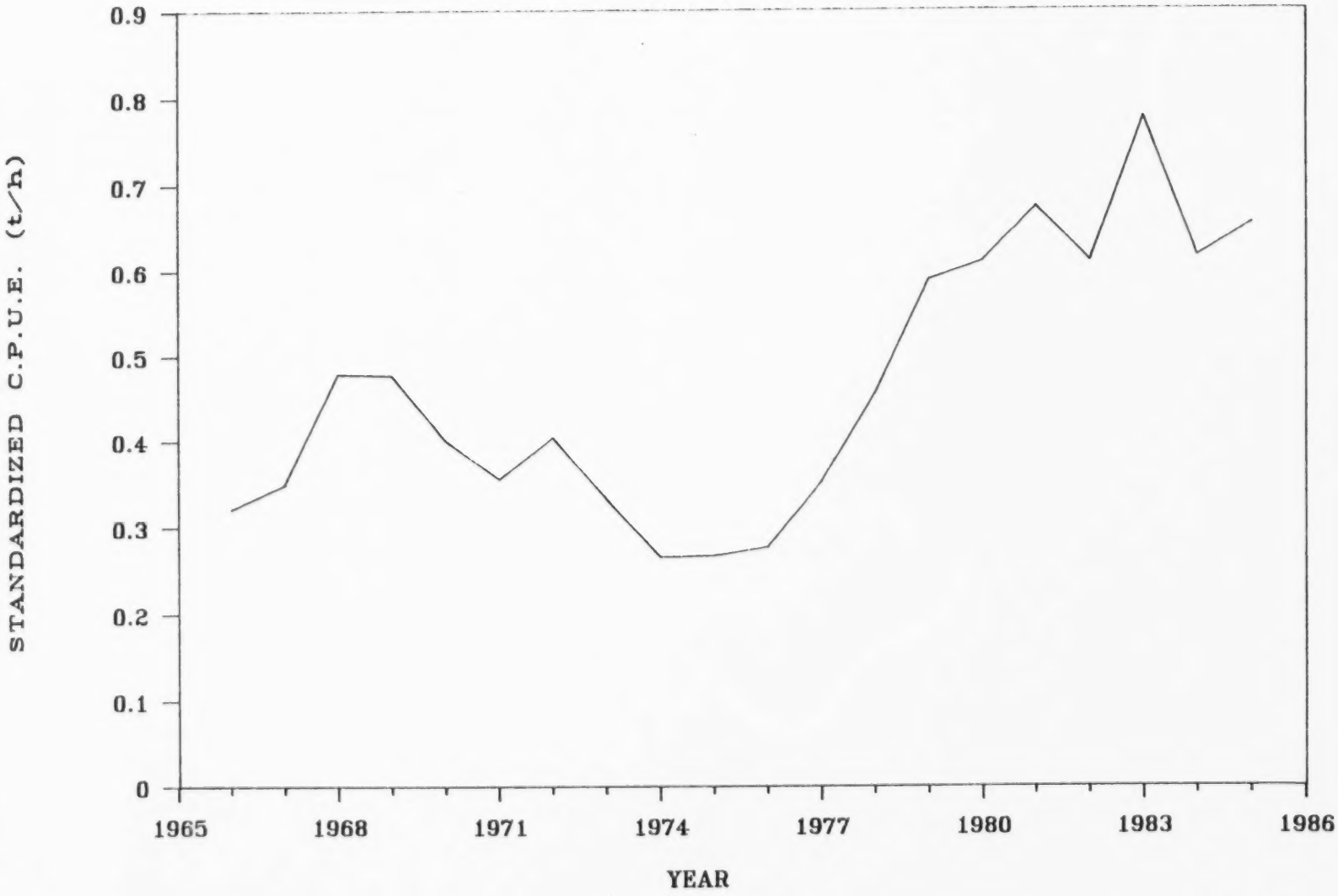


Figure 7 : Standardized catch rate for the 4T Vn cod stock 1966 - 1985

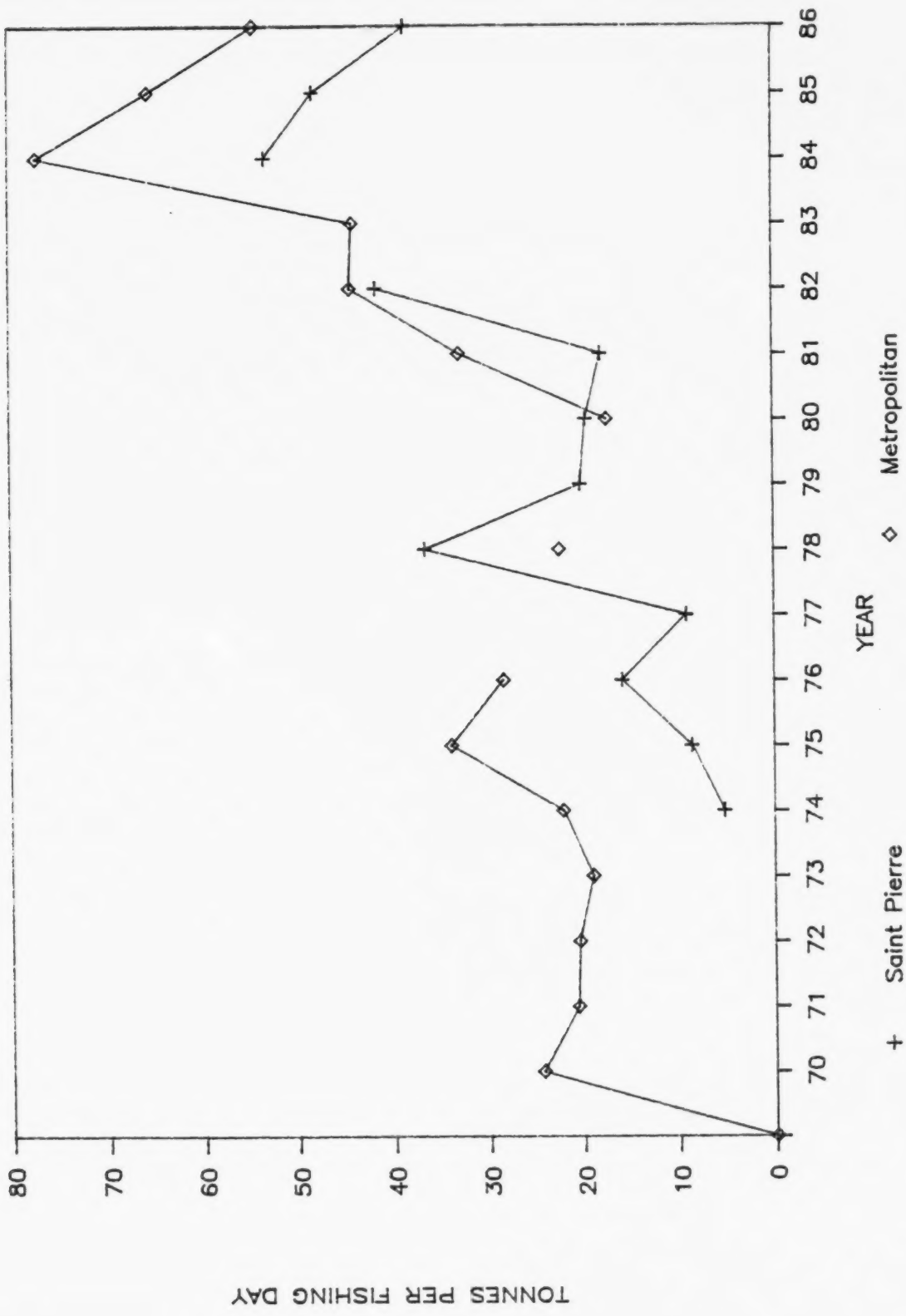


Figure 8. Catch rates (tonnes per fishing day) for French vessels in 4Vn (Source: 1970-1982: NAFO Statistical Bulletins, 1983-1986: Observer data)

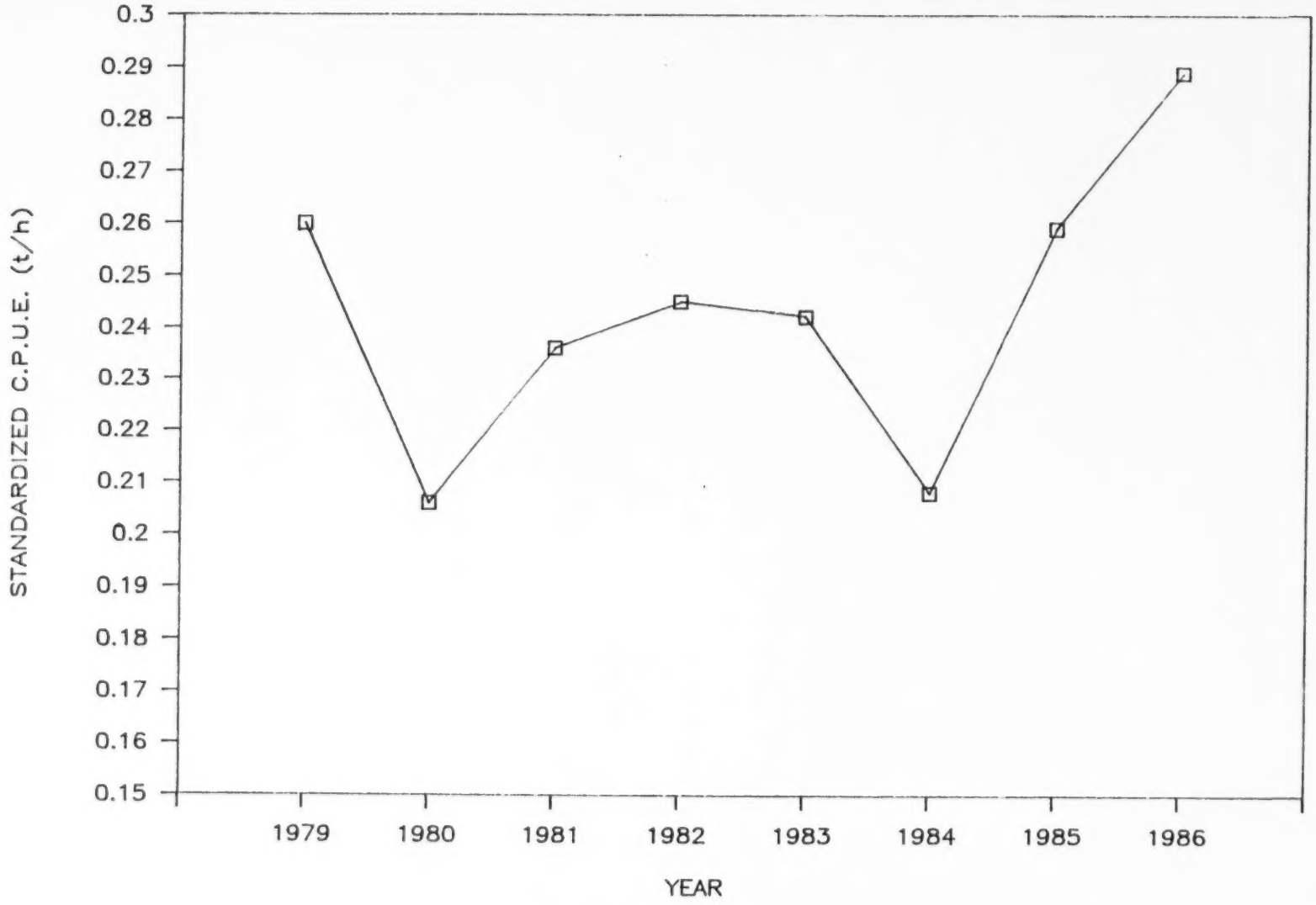


Figure 9: Standardized catch rate for Quebec in NAFO Division 4T (1979-1986)

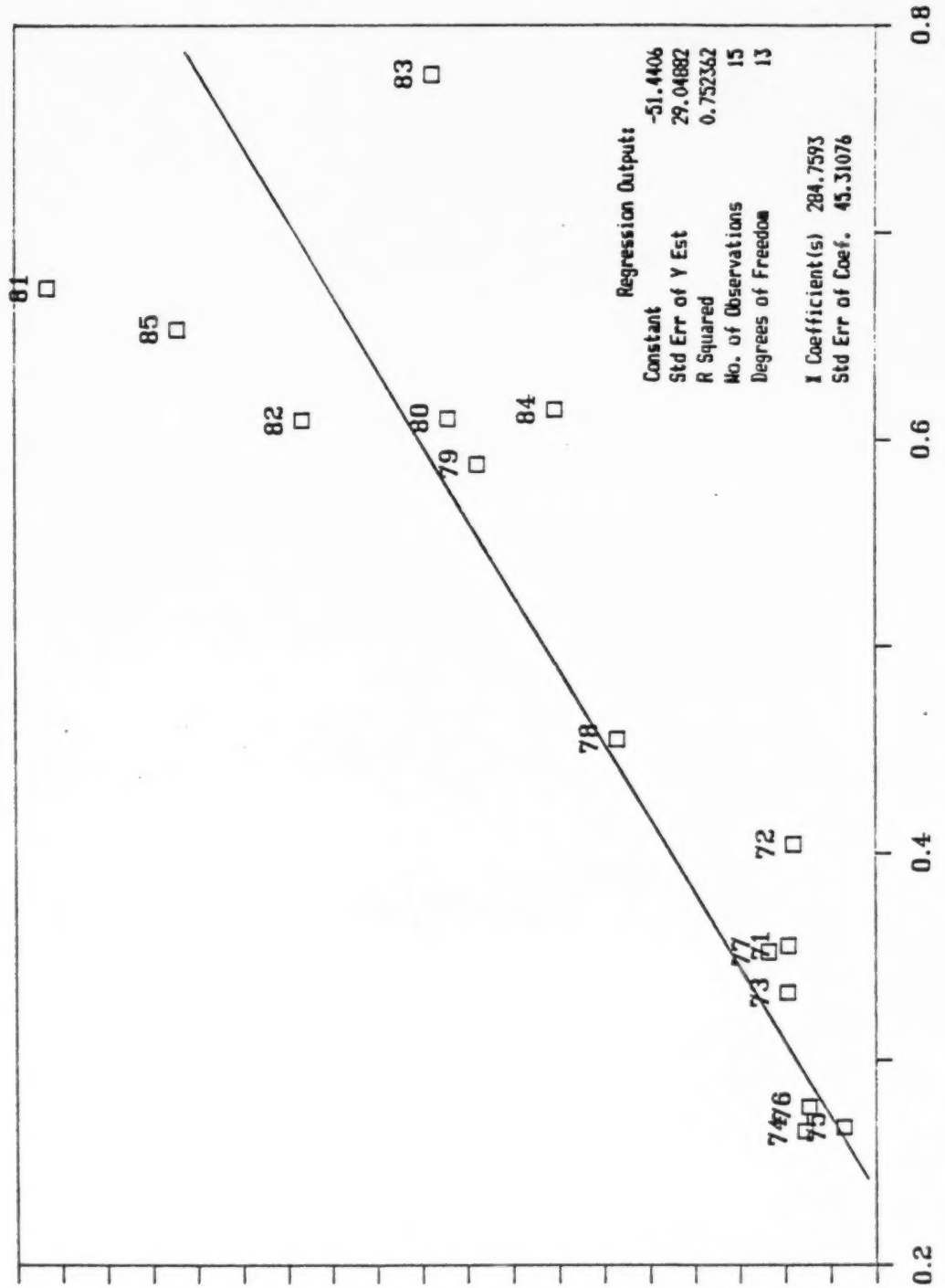
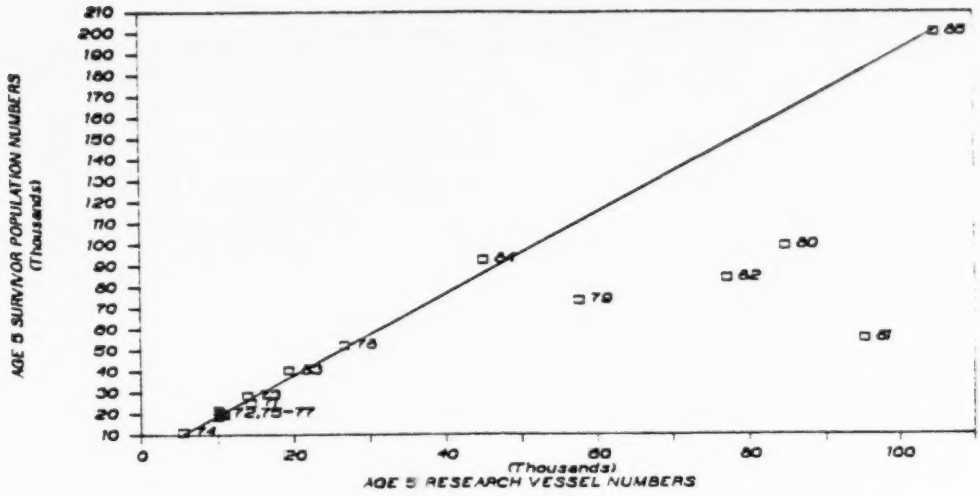
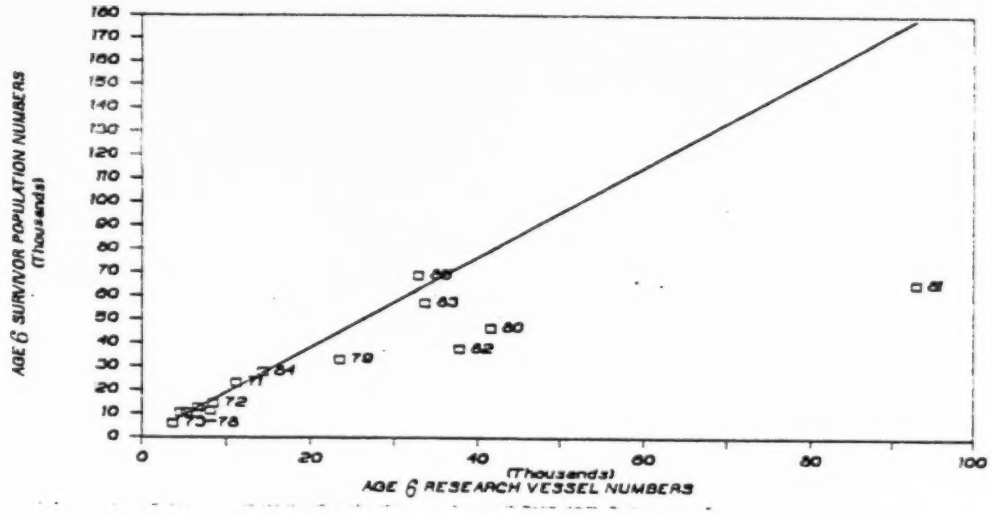


Figure10: Relationship between the weight per tow in research surveys and the commercial catch per unit of effort





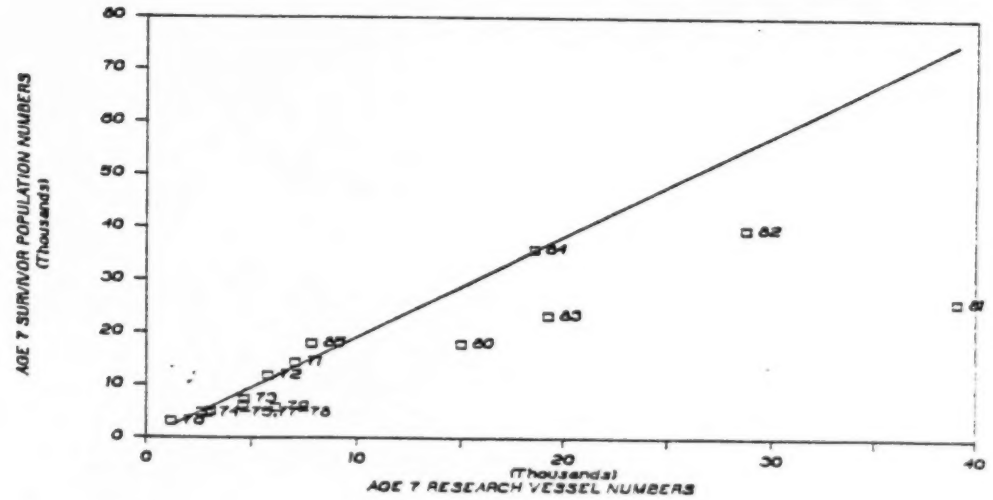
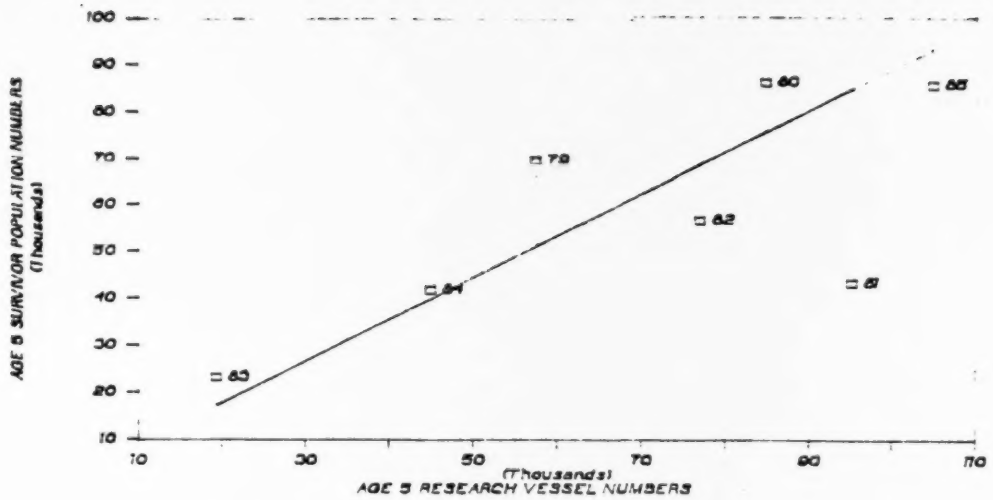
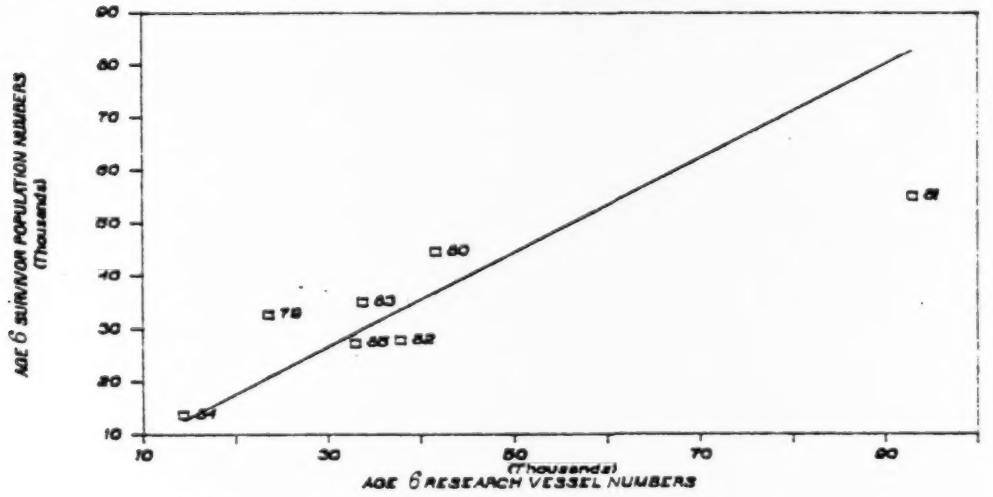


Figure 13 Age by Age plots from the survivor analysis for the period 1971 - 1985 showing the apparent break





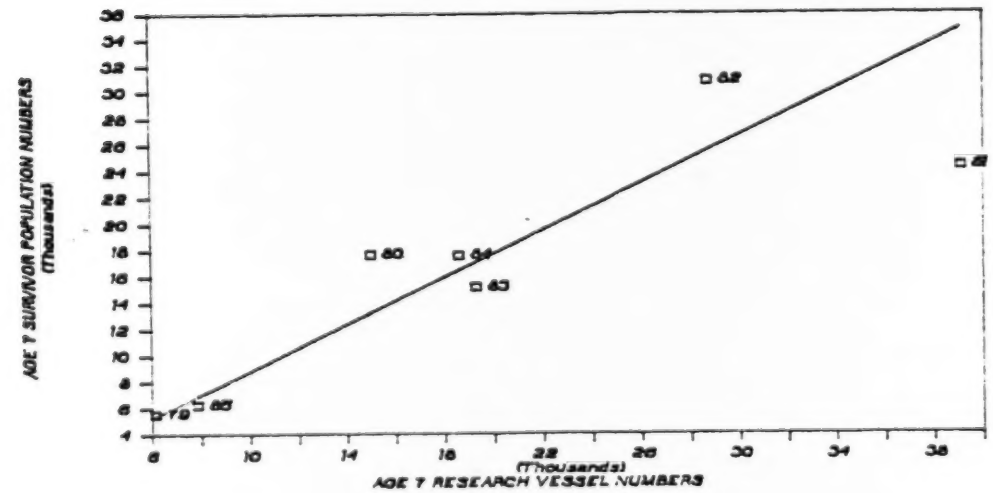


Figure 12: Age by Age plots for the survivor analysis for the period 1979-1985 (K = 0.89)

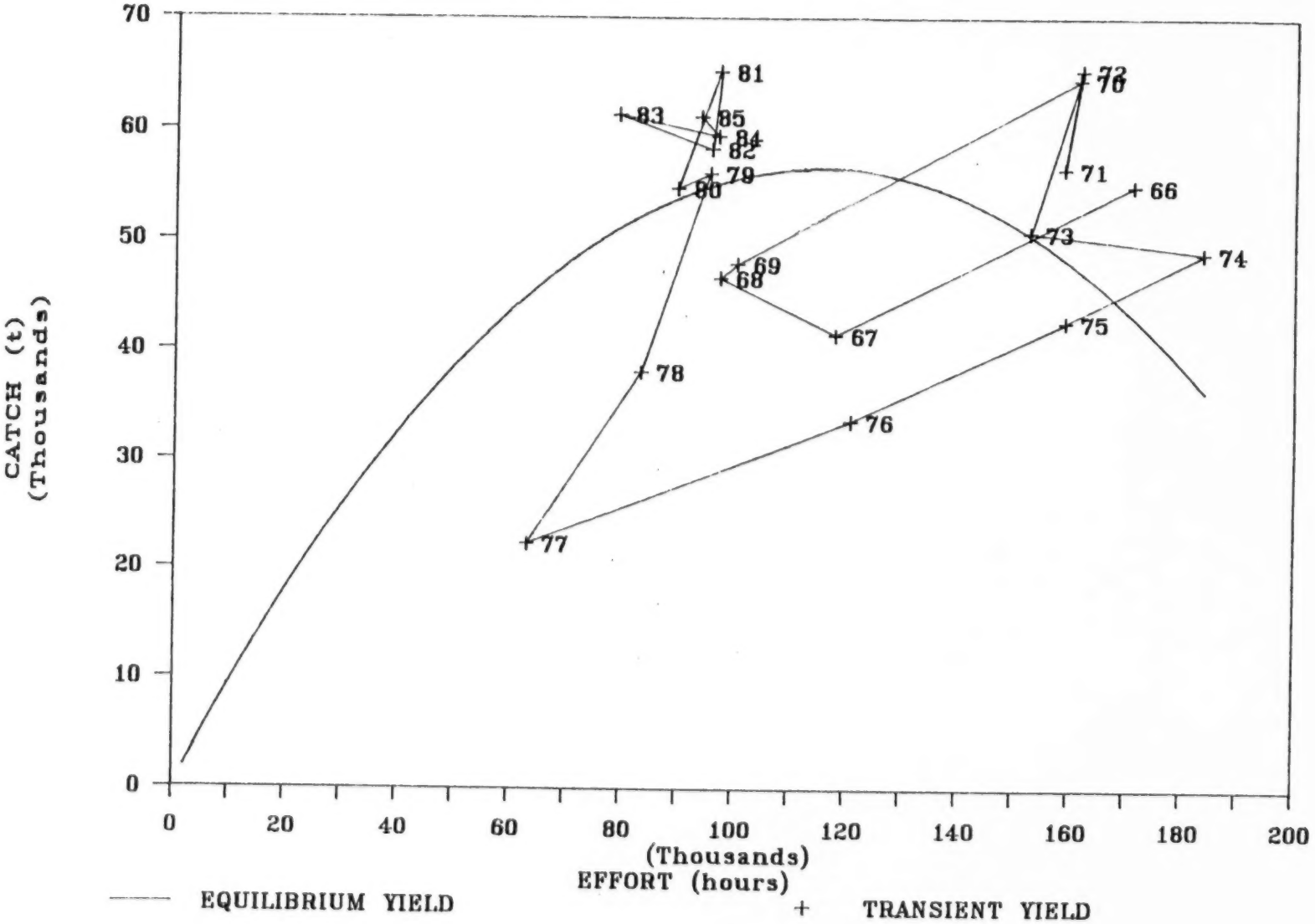


Figure 13 Plot of the Schaefer general production model equilibrium yield and transient yield observed.

Appendix I: Revised 4T cod catches during 1984 by gear type and month in Maritime Provinces, Newfoundland and Quebec.

MARITIMES

GEAR	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL	% OF 4TVn (Jan-Apr) CATCH
Otter trawl (side)	1367	-	-	274	992	357	147	13	13	50	91	19	3323	5.60
Otter trawl (stern)	782	105	44	82	403	265	130	142	65	219	441	1041	3719	6.27
Midwater trawl (side)	-	-	-	-	-	-	4	-	9	-	-	-	13	0.02
Shrimp trawl	-	-	-	-	127	-	-	-	3	60	26	21	237	0.40
Danish seine	1	-	-	1668	4088	863	523	429	258	653	1438	1295	11216	18.89
Scottish seine	-	-	-	-	601	153	31	-	-	4	45	22	856	1.44
Gillnet	3	5	-	85	2823	330	889	873	537	337	235	21	6138	10.34
Longline	2	-	-	7	22	60	9	65	39	163	566	343	1276	2.15
Handline	-	-	-	-	28	108	238	94	41	66	47	4	626	1.05
Traps	-	-	-	-	-	-	4	2	1	-	-	-	7	0.01
Miscellaneous	-	-	-	-	-	9	3	8	4	16	-	-	40	0.07
TOTAL	2155	110	44	2116	9084	2145	1978	1626	970	1568	2889	2766	27451	46.24

NEWFOUNDLAND

Otter trawl (side)	-	-	-	-	30	-	-	-	-	-	-	-	30	0.05
Otter trawl (stern)	607	-	43	81	-	-	40	-	1	33	4	-	809	1.36
Shrimp trawl	-	-	-	-	-	-	-	-	-	-	-	1	1	0.00
Gillnets	-	-	-	-	-	-	4	11	12	6	-		33	0.06
Longline	-	-	-	-	-	1	41	2	6	31	-	-	81	0.14
Handlines	-	-	-	-	-	-	2	5	13	1	1	-	22	0.04
Traps	-	-	-	-	-	-	25	-	-	-	-	-	25	0.04
TOTAL	607	0	43	81	30	1	112	18	32	71	5	1	1001	1.69

QUEBEC

Otter trawl (unsp.)	-	-	-	-	2	5	10	3	21	44	4	-	89	0.15
Otter trawl (side)	-	-	-	41	2263	997	604	513	620	1041	168	-	6247	10.52
Otter trawl (stern)	-	-	-	1	340	258	210	339	318	321	88	11	1886	3.18
Danish seine	-	-	-	-	-	14	7	6	11	-	-	-	38	0.06
Scottish seine	-	-	-	-	-	-	-	-	2	3	-	-	5	0.01
Gillnets	-	-	-	24	807	913	630	605	280	80	-	-	3339	5.63
Longline	-	-	-	4	268	192	584	467	339	341	38	-	2233	3.76
Handline	-	-	-	3	24	197	254	399	268	190	19	1	1355	2.28
Traps	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00
Miscellaneous	-	-	-	-	75	209	254	30	30	3	-	-	601	1.01
TOTAL	0	0	0	73	3780	2785	2553	2362	1889	2023	317	12	15794	26.61
TOTAL 4T	2762	110	87	2270	12894	4931	4643	4006	2891	3662	3211	2779	44246	74.54

Appendix II: Revised 4Vn cod catches during 1984 by gear type and month in Maritime Provinces, Newfoundland and France.

MARITIMES

GEAR TYPE	J	F	M	A	TOTAL	% OF 4TVn (Jan-Apr) CATCH
Otter trawl (side)	1591	1478	473	243	3785	6.38
Otter trawl (stern)	1155	626	387	460	2628	4.43
Danish seine	-	-	-	19	19	0.03
Scottish seine	-	-	-	48	48	0.08
Longline	77	-	-	1	78	0.13
TOTAL	2823	2104	860	771	6558	11.05

NEWFOUNDLAND

Otter trawl (side)	-	175	351	320	846	1.43
Otter trawl (stern)	142	-	-	507	649	1.09
TOTAL	142	175	351	827	1495	2.52

FRANCE

Otter trawl (stern)	4727	1704	629	-	7060	11.89
TOTAL OF 4Vn	7692	3983	1840	1598	15113	25.46

Appendix III: Results of the comparison between Gulf and St. Andrews age determinations (Winter 86).

St. Andrews

Gulf Age	0	1	2	3	4	5	6	7	8	9	10	11	12	
0		1												1
1	1	1	2											4
2			8	1										9
3				10	4									14
4					4	2								6
5						13	7							20
6							3	7						10
7								4	4	1				9
8									7	4	1			12
9											4			4
10											1	2	1	4
11												1		1
	1	2	10	11	8	15	10	11	11	5	6	3	1	94

Appendix IV:Results of the comparison between St. Andrews and Gulf (Summer 86).

ST ANDREWS

	AGE	2	3	4	5	6	7	8	9	10	11	12	13	14	15	TOTAL
	2															
	3		1	2												3
	4			4	3											7
	5				13	6	2									21
	6				1	8	3	1								13
GULF	7						5	3	5	1						14
	8							9	5	3		1				18
	9								3	4		3				10
	10									1	1	1		1		4
	11										1					1
	12									1			1		1	3
	TOTAL	0	1	6	17	14	10	13	13	10	2	5	1	1	1	94